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LICHENS
ALGAE

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MICHAEL WIRTH, SYO KUROKAWA

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*Errata: Line 23, page 164, should read **"24. Rhizines moderately branched;** lobes subrotund, often whitish . . ."

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VOLUME 36, PART 1

A REVISION OF THE SOUTH AMERICAN SPECIES OF PARMELIA DETERMINED BY LYNGE

By MASON E. HALE, JR.

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A REVISION OF THE SOUTH AMERICAN SPECIES OF PARMELIA DETERMINED BY LYNGE

MASON E. HALE, JR.

Introduction

Although the Norwegian lichenologist Bernt Lynge is remembered as the foremost authority on arctic lichens, early in his career he published several articles of fundamental importance on tropical lichens, especially in the genera *Anaptychia* and *Parmelia*. His major work (1914) involved the determination of the rich and well-prepared *Parmelia* collections, now preserved at Stockholm, of the various Regnell expeditions from 1892 to 1902 to Brazil and Paraguay. A second short paper (1917) merely added the descriptions of two new species, and a third paper (1925) summarized the determinations of miscellaneous Brazilian Parmelias at Uppsala, Stockholm, and Berlin.

Altogether Lynge identified a total of 110 taxa, 61 of them new to science, and gave exhaustive Latin descriptions of nearly all the species and excellent photographs of 30 taxa. It has been possible to reexamine 99 of these taxa; specimens of the remaining 11 were destroyed at Berlin or have otherwise not been located. The purpose of this report is to revise the determinations of these taxa with particular attention to adequate typification and analysis of chemical components. A full understanding of Lynge's species is essential before a monographic treatment of *Parmelia* in South America can be attempted.

The Regnell collections contained an extraordinarily large number of endemic species, many of which have never been collected again. Lynge, although on the whole he was a conservative taxonomist, wisely described these as new species instead of ascribing them to older names. At the same time the thoroughness of his work is attested by the fact that I have found it necessary to describe only one additional new species, *Parmelia microdactyla*. Most of my effort was expended in correcting misidentifications and synonymy stemming from Lynge's failure to typify the species correctly.

For the loan of valuable type specimens and other material, I am indebted to Dr. H. des Abbayes, Université de Rennes, Rennes, France; Dr. Sten Ahlner, Naturhistoriska Riksmuseum, Stockholm, Sweden; Dr. Charles Baehni, Conservatoire et Jardin Botanique, Geneva,

Switzerland; Dr. M. Skytte Christiansen, Botanical Museum, Leiden, Netherlands; Dr. Ilmari Hiitonen, University of Helsinki, Helsinki, Finland; Dr. I. Mackenzie Lamb, Farlow Herbarium, Cambridge, Massachusetts; Dr. Joseph Poelt, Botanische Staatssammlung, Munich, Germany; Dr. Rolf Santesson, Botanical Museum, Uppsala University, Uppsala, Sweden; and Dr. Antero Vaarama, Botanical Institute of the University, Turku, Finland.

Chemistry of the Species

The chemical components of each specimen were determined by means of the standard microchemical crystal tests of Asahina (1954), chromatography (Wachtmeister, 1956), and fluorescence analysis (Hale, 1956). Chromatography is required to separate the pigmented substances; fluorescence analysis at 3,600 A. is the easiest method of detecting the presence of alectoronic acid in the medulla (by a bright white fluorescence) and lichexanthone in the cortex (by a brilliant orange-yellow fluorescence). Color tests supplementing the microchemical tests were made under a low power binocular directly on the thallus and medulla with fresh reagents. Lynge made a number of faulty chemical color tests which resulted in some misidentifications and in some species being described as new unnecessarily.

Thirty lichen substances, including 17 positively identified and 13 unknown, were demonstrated. A list of the 17 positively identified acids and the species in which they occurred is given below. Changes in the nomenclature of Lynge's names should be checked in the list of synonyms and misidentifications on p. 39.

1. Alectoronic acid:
   - *P. bahiana* Nyl.
   - *P. laongii* Lynge
   - *P. latissima* f. *microspora* Lynge
   - *P. melanothrix* (Mont.) Vain.
   - *P. melanothrix* f. *microspora* Lynge
   - *P. rigida* Lynge
   - *P. subproboscidea* Lynge
   - *P. subrugata* var. *arcuata* Lynge
   - *P. wainii* A. L. Smith
2. Atranorine:
   Present in all taxa except:
   - *P. abstrusa* Vain.
   - *P. abstrusa* f. *laevigata* Lynge
   - *P. brasiliana* Nyl.
   - *P. brasiliana* var. *novella* (Vain.) Lynge
   - *P. chapadensis* Lynge
   - *P. crustacea* Lynge
   - *P. flava* var. *stellata* Lynge

2. Atranorine—Continued
   - *P. flava* var. *subdichotoma* Lynge
   - *P. malmei* Lynge
   - *P. minima* Lynge
   - *P. portoalegrensis* Lynge
   - *P. regis* Lynge
   - *P. regnellii* Lynge
   - *P. regnellii* f. *arida* Lynge
   - *P. rutidota* Hook. & Tayl.
   - *P. silvatica* Lynge
   - *P. silvatica* var. *pinnata* Lynge
   - *P. silvatica* var. *radiata* Lynge
   - *P. viridescens* Lynge
3. Barbatic acid:
   - *P. digitata* Lynge
   - *P. regnellii* Lynge
   - *P. uleana* Müll. Arg.
4. Divaricatic acid:
   - *P. rupicola* Lynge

5. Fumarprotocetraric acid:
   P. rutidota Hook. & Tayl.
   P. rutidota f. *filizans* Lynge
6. Gyrophoric acid:
   P. acariospora Zahlbr.
   P. coronata Fée
   P. marginalis Lynge
   P. minarum Vain.
   P. pluriformis Nyl.
   P. riograndensis Lynge
   P. rudecta Ach.
   P. sancti-angelii Lynge
   P. xanthina (Müll. Arg.) Vain.
7. Lecanoric acid:
   P. paraguariensis Lynge
   P. rissoensis Lynge
   P. tinctorum Nyl.
8. Lichexanthone:
   P. brasiliana Nyl.
   P. brasiliana var. *novella* (Vain.) Lynge
   P. crustacea Lynge
   P. malmei Lynge
   P. minima Lynge
   P. regis Lynge
   P. silvatica Lynge
   P. silvatica var. *pinnata* Lynge
   P. silvatica var. *radiata* Lynge
9. Norstictic acid:
   P. abstrusa Vain.
   P. abstrusa f. *laevigata* Lynge
10. Olivetoric acid:
   P. fragilis Lynge
   P. revoluta Floerke
11. Perlatolic acid:
   P. wainioana Lynge
12. Protocetraric acid:
   P. amazonica Nyl.
   P. consimilis Vain.
   P. crustacea Lynge
   P. cyliphora (Ach.) Vain.
   P. fatiscens Lynge
   P. fistulata Tayl.
   P. flava var. *stellata* Lynge
   P. flava var. *subdichotoma* Lynge
   P. latissima Fée
   P. latissima var. *corniculata* Krempl h.
   P. latissima var. *minima* Lynge
   P. leucoxantha Müll. Arg.
   P. malmei Lynge
   P. minima Lynge
   P. rutidota Hook. & Tayl.

12. Protocetraric acid—Continued
   P. saccatiloba Tayl.
   P. silvatica Lynge
   P. silvatica var. *pinnata* Lynge
   P. silvatica var. *radiata* Lynge
13. Protolichesteric acid:
   P. canaliculata Lynge
   P. microsticta Müll. Arg.
   P. riograndensis Lynge
   P. xanthina (Müll. Arg.) Vain.
14. Salacinic acid:
   P. cetrata Ach.
   P. cetrata var. *corniculata* Müll. Arg.
   P. cetrata ssp. *radiata* Lynge
   P. cinerascens Lynge
   P. continua Lynge
   P. cristifera Lynge
   P. kamtschadalis var. *americana* (Mey. & Flot.) Nyl.
   P. latissima Fée
   P. magna Lynge
   P. microdactyla Hale
   P. nylanderi Lynge
   P. radians Lynge
   P. rupta Lynge
15. Stictic acid:
   P. conspersa (Ach.) Ach.
   P. eciliata (Nyl.) Nyl.
   P. longiconida Lynge
   P. portoalegrensis Lynge
   P. regnellii Lynge
   P. scrobicularis Krempl h.
   P. uleana Müll. Arg.
16. Usnic acid:
   P. abstrusa Vain.
   P. abstrusa f. *laevigata* Lynge
   P. chapadensis Lynge
   P. conspersa (Ach.) Ach.
   P. cristifera Tayl.
   P. cyliphora (Ach.) Vain.
   P. fatiscens Lynge
   P. flava var. *stellata* Lynge
   P. flava var. *subdichotoma* Lynge
   P. leucoxantha Müll. Arg.
   P. magna Lynge
   P. microdactyla Hale
   P. nylanderi Lynge
   P. portoalegrensis Lynge
   P. radians Lynge
   P. regnellii Lynge
   P. regnellii f. *arida* Lynge
   P. rutidota Hook. & Tayl.

16. Usnic acid—Continued
P. rutidota f. *filizans* Lynge
P. uleana Müll. Arg.
P. xanthina (Müll. Arg.) Vain.

17. Vulpinic acid:
P. cornuta Lynge
P. persulphurata Nyl.
P. sulphurata Nees & Flot.

Unknown colorless substances were found in the following species:

P. annae Lynge
P. brasiliana var. *novella* (Vain.) Lynge
P. capitata Lynge
P. ceracea Lynge
P. chapadensis Lynge
P. digitata Lynge
P. gracilis (Müll. Arg.) Vain.
P. melanothrix (Mont.) Vain.
P. mesotropa Müll. Arg.
P. osseo-albida Lynge
P. palmarum Lynge
P. regis Lynge
P. regnellii Lynge
P. regnellii f. *arida* Lynge
P. riograndensis Lynge
P. saccatiloba Tayl.
P. saccatiloba f. *membranacea* Lynge
P. subregressa Lynge
P. zahlbruckneri Lynge

Unknown pigments were discovered in the following species:

P. chapadensis Lynge
P. cornuta var. *crocea* Lynge
P. crustacea Lynge
P. lindmanii Lynge
P. malmei Lynge
P. merrillii Lynge
P. minima Lynge
P. regnellii Lynge
P. regnellii f. *arida* Lynge
P. silvatica Lynge
P. silvatica var. *pinnata* Lynge
P. silvatica var. *radiata* Lynge
P. uleana Müll. Arg.

List of Species

Lynge originally arranged his lists of 110 taxa in phylogenetic order. I have, for convenience, rearranged the species in alphabetical order and have numbered them consecutively. No descriptions are repeated from Lynge since he described meticulously nearly all the species in his 1914 article in Arkiv för Botanik, which is readily available in most larger libraries. I have, however, included supplemental information on the nomenclatural types, synonymy, range, color reactions and chemical components, and pertinent comments on the status of the species and their relatives. I have not attempted to improve or expand Lynge's excellent, though outdated key, for our knowledge of the Parmelias of South America is so incomplete that no key can do justice to the genus now.

The Malme specimens from the Regnell collections, all of which are preserved at Stockholm, are cited only by number or date, since Lynge gives complete label data for these in his lists. Holotypes and lectotypes are cited in full. Specimens collected by Dusén, Henschen, or Regnell, mostly preserved at Uppsala, are also cited in full.

Lynge did not designate holotypes for his new taxa in his publications, but he did write "originaleksemplar" on one herbarium packet

if two or more specimens were included in the original concept. I have selected such packets as lectotypes except in the case of *P. zahlbruckneri* Lynge (see p. 38). A summary of the new taxa reduced to synonymy and corrected identifications is given at the end of this list (p. 39).

1. Parmelia abstrusa Vain. Acta Soc. Faun. & Fl. Fenn. 7:64. 1890.—Lynge, 1914, p. 145, *pl. 5, figs. 8, 9;* 1925, p. 84.

Lectotype: Caraça, Minas Gerais, Brazil, *Vainio* 1347 (TUR).

Range: Brazil, Colombia, West Indies, Japan.

Additional specimens examined: *Malme* 1481B, 1537, 1857, 1865B, 1884, 2745, 2749B.

Reactions: Thallus K−, medulla K+ red, C−, KC−, P+ orange-red, norstictic and usnic acids present.

The specimens seen by Lynge fall within the range of variation of Vainio's species, although the thickness of the thallus is quite variable. A very close relative with thinner lobes is *P. jamaicensis* Vain., which also contains norstictic acid and usnic acid, and probably intergrades with *P. abstrusa* in the West Indies. Both species appear to be common on soil and rocks as well as on tree bark. *Parmelia microblasta* Vain., judging from the poor type material, is in this same group of isidiate species with norstictic acid but differs in lacking usnic acid.

2. Parmelia abstrusa f. **laevigata** Lynge, Ark. Bot. 13, No. 13:147. 1914.
Parmelia subabstrusa Gyel. Repert. Sp. Nov. 29:288. 1931. Based on *P. abstrusa* f. *laevigata* Lynge.

Lectotype: Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme*, June 15, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K−, medulla K+ red, C−, KC−, P+ orange-red, norstictic and usnic acids present.

The lack of isidia and the conspicuous coronate apothecia set this entity quite apart from *P. abstrusa* f. *abstrusa*. In fact, we may well wonder why Lynge did not recognize it as a new species. The adoption of Gyelnik's name as a distinct species is recommended, although it does not clear up the confusion surrounding this difficult group. Two specimens seen by Lynge (*Malme* 2445 and March 7, 1894) react K− in the medulla and may be classified either as a chemical strain of *P. subabstrusa* or as an undescribed species more closely related to *P. relicina* Fr.

3. Parmelia acanthifolia Pers. *in* Gaudich. Voyage *Uranie*, Bot. 197. 1826.—Lynge, 1925, p. 84. PLATE 1

Type: Rio de Janeiro, Brazil, *Gaudichaud* 13 (P).

The specimen determined by Lynge in the Berlin Museum is presumably destroyed. Persoon's type is apparently an abnormal form

of *P. cetrata* Ach. The upper cortex is less reticulately rimose than expected, but the plant contains atranorine and salacinic acid and has spores (8–11×12–16 μ) comparable to *P. cetrata*. Vainio's determination of *P. acanthifolia* from Brazil (*Lich. Bras. Exs.* 737) is based on *P. subcaperata* Kremplh.

4. Parmelia acariospora Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:169. 1909.—Lynge 1914, p. 105.

Type: Barra Mansa, Itapecirica, São Paulo, Brazil, *Schiffner & Wettstein* (BPI, isotype).

Range: Brazil.

Additional specimens examined: *Malme* 2509B, 2532B*, 2545.

Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

This uniform species is easily recognized by its thin fragile thallus and delicate isidia. *Parmelia minarum* Vain. is similar in chemistry and appearance but has a more ashy color and firmer lobes. *Parmelia granatensis* Nyl. and *P. chileana* Nyl. are also related to this species, but their exact status is unsettled.

5. Parmelia amazonica Nyl. Flora 68:611. 1885—Lynge, 1914, p. 101.

Type: Santarem, Amazon River, Bahia, Brazil, *Spruce* 111 (H).

Range: Florida, West Indies, Central America, Brazil.

Additional specimen examined: *Malme* 2408.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine and protocetraric acid present (not proved microchemically in the type specimen).

Parmelia amazonica is distinguished by the presence of protocetraric acid. *Parmelia consimilis* Vain. of similar chemical constitution has thicker crowded isidia.

6. Parmelia annae Lynge, Ark. Bot. 13, No. 13:88, *pl. 2, fig. 6*. 1914.

Lectotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2368B (S).

Additional specimen examined: *Malme*, June 27, 1894.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and two colorless unknowns, one forming tetragonal lamellae, the other needles in the reagent G.A.W.

The two specimens of *P. annae* and *P. ceracea* Lynge (see p. 9) agree chemically and morphologically with *P. recipienda* Nyl. (type: Brazil, Nylander Herbarium No. 35212, H), and both species are synonyms of *P. recipienda*. The medulla of *P. annae* was reported by Lynge to be K+ red. Evidently he obtained such a reaction from a single unpublished collection (Colonia Risso, Paraguay, *Malme* 1959, S), labeled *P. annae* but actually belonging to *P. subcaperata* Kremplh., which contains salacinic acid (K+ red).

7. Parmelia bahiana Nyl. Flora 68:612. 1885.—Lynge 1914, p. 134; 1925, p. 84.

Lectotype: Rio de Janeiro, *Glaziou* 1999 (H).

Range: Brazil.

Additional specimen examined: *Malme* 2545**.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid (in *Malme* 2545**) or an unidentified substance (in the lectotype), other specimens not tested.

The only diagnostic character of *P. bahiana* is the KC + medullary reaction attributable to two different substances, as far as I can determine. Since the chemically different specimens are so close morphologically, I dare not describe Lynge's material as a new species, for it belongs to the particularly difficult nonisidiate, esorediate group of the section *Hypotrachyna*. The specimens collected by Dusén and Warming (UPS) were too fragmentary for certain identification.

8. Parmelia balansae Müll. Arg. Rev. Mycol. 10:1. 1888.—Lynge, 1914, p. 51.

Lectotype: Asunción, Paraguay, *Balansa* 8 (G).

Lynge determined *Malme* 201B as this species; the specimen has not been made available for study, but there is little doubt but that Lynge's determination is correct. *Parmelia balansae* is closely related to *P. consors* (see p. 11).

9. Parmelia balansae var. **sorediata** Müll. Arg. Rev. Mycol. 10:2. 1888.—Lynge, 1914, p. 53, *pl. 1, fig. 6*; 1925, p. 84.

Parmelia subbalansae Gyel. Repert. Sp. Nov. 33:288. 1931. Based on *P. balansae* var. *sorediata* Müll. Arg.

Type: Montevideo, Uruguay, *Arechavaleta* in 1887 (G).

Range: Argentina, Brazil, Uruguay.

Additional specimen examined: *Malme*, September 7–9, 1894.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine present.

Lynge's specimen agrees perfectly with the holotype of the variety, which, following Gyelnik, should be recognized as a distinct species, *P. subbalansae* Gyel., which differs from *P. balansae* var. *balansae* in possessing laminal soredia. *Parmelia subbalansae* appears to be much more common than *P. balansae*.

10. Parmelia borreri (J. E. Smith) Turn. Trans. Linn. Soc. 9:148. 1808.—Lynge, 1925, p. 84.

Lichen borreri J. E. Smith, Eng. Bot. 25:1780. 1807.

The material of this species determined by Lynge was destroyed at Berlin. The citation as given above is the correct name for the currently accepted *P. dubia* (Wulf. in Jacq.) Schaer. non (Ach.) Floerke.

11. Parmelia brasiliana Nyl. Flora 68:611. 1885.—Lynge, 1914, p. 113.

Type: Organ Mountains, Rio de Janeiro, Brazil, *Weddell* (not seen).

Specimens examined: *Malme* 309, 312B. Reactions: Thallus K−, medulla K−, C−, KC−, P−, lichexanthone present.

Although the type has not been checked, the identity of this distinctive species has not been questioned by previous workers.

12. Parmelia brasiliana var. **glaziovii** (Müll. Arg.) Lynge, Nyt Mag. Naturv. 62:85. 1925.

Parmelia glaziovii Müll. Arg. Nuov. Giorn. Bot. Ital. 21:353. 1889.

The Henschen specimen cited by Lynge and preserved at Uppsala has not been available for study.

13. Parmelia brasiliana var. **novella** (Vain.) Lynge, Ark. Bot. 13, No. 13:115. 1914.—Lynge, 1925, p. 85.

Parmelia novella Vain. Acta Soc. Faun. & Fl. Fenn. 7:56. 1890.

Type: Minas Gerais, Brazil, *Vainio* 1028 (FH, isotype).

Range: Brazil.

Additional specimens examined: *Malme* 2246B; *Hemmensdorf* in 1898 (UPS).

Reactions: Thallus K−, medulla K+ dull reddish, C−, KC+ reddish, P+ faint orange-red, lichexanthone and unknown substances present.

The status of this entity is not clear at this time. It probably falls nearer *P. silvatica* Lynge (see p. 34) than *P. brasiliana* because of the small, adnate thallus.

14. Parmelia canaliculata Lynge, Ark. Bot. 13, No. 13:28, *pl. 1, fig. 1.* 1914.—Lynge, 1925, p. 85.

Holotype: Cachoeira, Rio Grande do Sul, Brazil, *Malme* 1055, February 17, 1893 (S).

Range: Brazil, Argentina, Uruguay.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

This unique species appears superficially to be in the *P. melanothrix* group, but on closer inspection it is found to have pseudocyphellae and lack cilia. Most of the specimens determined by Lynge in 1925 were destroyed at Berlin.

15. Parmelia capitata Lynge, Ark. Bot. 13, No. 13:59, *pl. 1, figs. 4, 5.* 1914.

Holotype: Rio Vermelho, near Bahia, Bahia, Brazil, *Malme,* October 1894 (S).

Range: Brazil, West Indies.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and an unidentified fatty substance near caperatic acid.

The name *P. capitata* has appeared in the literature several times, but such reports are usually based on misidentifications. *Parmelia capitata* is a small plant—so small that one would question its inclusion in the section *Amphigymnia*. *Parmelia sanctae-crucis* Vain. (cf. Hale, 1959a, p. 22), a common tropical species with similar chemistry, is twice the size of *P. capitata*. One specimen from the West Indies (Roseau, Dominica, *Evans*, US, YU) can probably be referred here.

16. Parmelia ceracea Lynge, Ark. Bot. 13, No. 13:97. 1914.—Lynge, 1925, p. 85.

Lectotype: Pilcomayo, Gran Chaco, Paraguay, *Malme*, September 7, 1893 (S).

Additional specimens examined: Caldas, Minas Gerais, Brazil, *Henschen* in 1868 (UPS).

Reactions: As in *P. annae* Lynge.

The two specimens agree chemically and morphologically with *P. recipienda* Nyl. (see under *P. annae* Lynge, p. 6), a rare but widespread species in Brazil, Argentina, and Paraguay.

17. Parmelia cetrata Ach. Syn. Lich. 198. 1814.—Lynge, 1914, p. 90; 1925, p. 86.

Type: North America, *Muhlenburg* (PH, isotype).

Range: Cosmopolitan in temperate and tropical regions.

Additional specimens examined: *Malme* 463, June 25, 1894, October 14–16, 1902.

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

Du Rietz (1924, p. 330) correctly circumscribed *P. cetrata* as an esorediate species with a reticulately rimose cortex and a uniformly rhizinate underside. Although specimens determined by Lynge which I have been able to verify all lack soredia, his concept of the species included sorediate plants also, which should be referred to *P. reticulata* Tayl.

18. Parmelia cetrata f. ciliosa Viaud-Grand-Marais, Bull. Soc. Ouest France 2:156. 1892.—Lynge, 1925, p. 86.

Material of this form which Lynge examined was not available for study.

19. Parmelia cetrata var. **corniculata** (Krempih.) Müll. Arg. Hedwigia 32:228. 1891.—Lynge, 1914, p. 93; 1925, p. 86.

Parmelia perforata var. *corniculata* Krempih. Naturhist. For. Kjöbenhavn Vid. Medd. 1873:11.

Type: Rio de Janeiro, Brazil, *Warming* (not seen).

Range: North and South America.

Specimens examined: *Malme* 313, September 3, 1893, and January 25, 1893. Reactions as in *P. cetrata* var. *cetrata.*

The correctness of this identification is undoubted.

20. Parmelia cetrata subsp. **radiata** Lynge, Ark. Bot. 13, No. 13:94. 1914.

Lectotype: Colonia Risso, near Río Apa, Paraguay, *Malme* 1834, September 23, 1893 (S).

Range: Brazil and Paraguay.

Additional specimen examined: *Malme*, June 15, 1894.

Reactions: As in *P. cetrata* var. *cetrata.*

Lynge based this subspecies on the more or less radiating arrangement of the lobes and noted in addition that the upper cortex was not reticulately rimose to the margins, but merely white-maculate. It is not uncommon, however, to find a similar condition in specimens of both *P. cetrata* and *P. reticulata* Tayl.

21. Parmelia chapadensis Lynge, Ark. Bot. 13, No. 13:153. 1914.

Holotype: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2297B, January 21, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellowish, KC+ strong yellow, medulla K+ yellow, C−, KC+ orange-yellow, P+ orange-yellow, usnic acid, an unidentified pale yellow pigment (in the medulla), and a P+ substance, probably near protocetraric acid.

This saxicolous species at first seems like an oversized specimen of the crustose *Rinodina oreina* (Ach.) Mass. rather than a *Parmelia.* It is a unique species with no near relatives in the genus.

22. Parmelia cinerascens Lynge, Ark. Bot. 13, No. 13:104. 1914.

Holotype: Paraguari, Paraguay, *Malme* 1498, August 2, 1893 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

In gross appearance this species is near *P. minarum* Vain. but produces salacinic acid.

23. Parmelia coccinea Lynge, Ark. Bot. 15, No. 1:3. 1915.

Parmelia ochrococcinea Zahlbr. Cat. Lich. Univ. 8:562. 1932. A new name for *P. coccinea* Lynge non Clem.

Lynge (1925, p. 97) had already reduced this species to synonymy under *Pyxine coccifera* (Fée) Nyl., when Zahlbruckner made a new name.

24. Parmelia congruens Ach. Lich. Univ. 491. 1810—Lynge, 1925, p. 87.

Type: North America, *Swartz.* The identity of this species has long been a source of confusion to lichenologists. There is no specimen in the Acharian herbarium according to Mr. Teuvo Ahti (in litt.).

A presumed isotype at Uppsala is a pale yellow, nonisidiate plant of the section *Xanthoparmelia*, even though Acharius described it as "albo-pallescens . . . sordide albo." The chemistry of this fragmentary specimen is not clear.

Two specimens identified by Lynge have not been seen. A duplicate of one of them (Argentina, *Lorentz & Hieronymus*, M) is the type of *P. taractica* Krempelh., a recognized species in the section *Xanthoparmelia* not to be compared with *P. congruens*.

25. Parmelia consimilis Vain. Acta Soc. Faun. & Fl. Fenn. 7:58. 1890.—Lynge, 1925, p. 87.

Lectotype: Sitio, Minas Gerais, Brazil, *Vainio* 1133 (FH).

Range: Brazil, West Indies.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine and protocetraric acid present.

The specimen of Henschen (UPS) examined by Lynge consists of an *Anaptychia* species and a fragment of a sorediate *Parmelia*, not *P. consimilis*, which is isidiate.

26. Parmelia consors Nyl. Flora 68:613. 1885.—Lynge, 1914, p. 95, *pl. 3, fig. 1*; 1925, p. 87.

Lectotype: Brazil, *Weddell* (H, Nylander Herbarium No. 35276).

Range: Brazil.

Additional specimen examined: *Malme* 1282.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine present.

Malme's specimen is well developed and typical. This species must be very near *P. balansae* Müll. Arg. Both have a rigid, finely white-maculate thallus and produce only atranorine. *Parmelia consors* has a dark underside, densely rhizinate to the margins, whereas *P. balansae* becomes lighter brown at the margins with a narrow papillate or almost bare zone below.

27. Parmelia conspersa (Ach.) Ach. Meth. Lich. 205. 1803.—Lynge, 1914, p. 142; 1925, p. 87.

Lichen conspersus Ach. Lich. Suec. Prod. 118. 1798.

Type: Europe (not seen). According to Gyelnik (1936, p. 120), the Acharian type is a mixture of nonisidiate *P. conspersa* and isidiate *P. isidiata* (Anzi) Gyel. I have advocated the acceptance of both species (Hale, 1955).

Range: Cosmopolitan.

Specimens examined: *Malme* 563, 1346. Reactions: Thallus K−, medulla K+ yellow, C−, KC−, P+ pale orange, stictic and usnic acids present.

The two Malme specimens are isidiate and should be classified as *P. isidiata*, an entity which Lynge recognized as a variety. A

third specimen (*Malme* 248) lacking isidia is *P. flavida* Zahlbr. (see under *P. flava* Kremplh., p. 15).

28. Parmelia conspersa var. **hypoclysta** Nyl. Syn. Meth. Lich. 1:391. 1860.—Lynge, 1925, p. 87.

The specimen seen by Lynge was destroyed at Berlin.

29. Parmelia continentalis Lynge, Ark. Bot. 13, No. 13:111. 1914.—Lynge, 1925, p. 87.

Holotype: Corumba, Mato Grosso, Brazil, *Malme* 48, August 1, 1894 (S).

Range: Brazil, Paraguay.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine present.

The only distinguishing feature of this *Hypotrachyna* species is the exceptionally rigid thallus.

30. Parmelia continua Lynge, Ark. Bot. 13, No. 13:109. 1914.

Holotype: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme* June 19, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

This unusual member of the section *Hypotrachyna* lacks soredia and isidia and produces salacinic acid. It may be a nonisidiate variant of *P. cinerascens* Lynge.

31. Parmelia cornuta Lynge, Ark. Bot. 13, No. 13:76, *pl. 2, fig. 5.* 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2477, March 2, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and vulpinic acid present.

Parmelia cornuta has the same chemical composition as the better known *P. sulphurata* Nees & Flot. but lacks isidia and has longer cilia and a more rigid thallus.

32. Parmelia cornuta var. **crocea** Lynge, Ark. Bot. 13, No. 13:78. 1914.
Parmelia crocea (Lynge) Gyel. Repert. Sp. Nov. 29:287. 1931. This is a later homonym of *Parmelia crocea* (Ach.) Sprengl.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2477 bis, March 2, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla flava K+ yellowish, C−, KC+ yellowish, P−, medulla crocea K+ purple, atranorine, a pale yellow-orange pigment (also known in *P. lindmanii* Lynge and

P. merrillii Lynge (= *P. lyngeana* Zahlbr.)), and an unidentified anthraquinone.

Although Lynge relied on the orange-red lower medulla to differentiate this variety, it actually contains a yellow pigment entirely different from that in var. *cornuta* (vulpinic acid). On the basis of both spore size and chemistry, var. *crocea* is closer to *P. merrillii* Lynge (see p. 24) than to *P. cornuta*. We should continue to recognize it as a variety rather than coin another new species name, at least until additional material throws more light on the range of variation in this group.

33. Parmelia coronata Fée, Essai Crypt. Ecorces, 123, *pl. 31, fig. 2.* 1824.—Lynge 1914, p. 121; 1925, p. 88.

Type: American tropics (not seen); Fée's color plate permits almost certain identification of the species.

Range: Tropical America.

Specimens examined: *Malme* 2392, 2511Ba, 2522G, 2525a. Reactions: Thallus K+ yellow, medulla K—, C+ rose, KC+ red, P—, atranorine and gyrophoric acid present.

The Malme specimens are well developed and typical.

34. Parmelia cristifera Tayl. London Journ. Bot. 6:165. 1847.—Lynge, 1914, p. 46.

Lectotype: Calcutta, India, *Wallich* (FH).

Range: Tropical regions, especially in the Pacific area.

Reactions: Thallus K+ yellow, medulla K+ red, C—, KC—, P+ orange-red, atranorine and salacinic acid present.

The single specimen cited by Lynge (*Malme*, June 16, 1894) contains atranorine, protocetraric acid, and usnic acid, and has the upper cortex more or less reticulately cracked. It is certainly not referable to *P. cristifera* but may be allied to *P. dominicana* Vain. The material, however, is too poor for satisfactory determination.

35. Parmelia crustacea Lynge, Ark. Bot. 13, No. 13:108, *pl. 3, fig. 4.* 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme*, February 21, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K—, medulla alba K—, C—, KC+ faint rose, P+ orange-red, medulla crocea K+ purple, lichexanthone, protocetraric acid, and an unidentified anthraquinone present.

This species is very closely related to *P. silvatica* Lynge (see p. 34), from which it is distinguished by a more adnate growth habit. Lynge's separation of the two species in his key (1914, pp. 20–21) into different groups (*Cyclocheila* and *Sublineares*) is entirely unsatisfactory.

36. Parmelia crystallorum Lynge, Ark. Bot. 13, No. 13:128. 1914.

Holotype: Corcovado, Rio de Janeiro, Brazil, *Malme* 59*, August 14, 1892 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine present.

Lynge characterized the species by the large colorless crystals which precipitated from the medulla in KOH; the identity of these crystals is unknown, and the type specimen is too small and fragile for adequate chemical analyses. The species resembles *P. zahlbruckneri* Lynge (see under *P. gracilis*, p. 17) in general appearance, especially with regard to the lobation and the ivory or ashy colored shiny surface.

37. Parmelia cyliphora (Ach.) Vain. Acta Soc. Faun. & Fl. Fenn. 13:7. 1896.—Lynge, 1914, p. 60.

Parmelia caperata (L.) Ach. var. *cyliphora* Ach. Syn. Lich. 196. 1814.

P. caperata auct.

Type: North America (UPS, isotype). The Acharian isotype is somewhat smaller than but otherwise identical with *P. caperata* var. *caperata*. The identity of *Lichen caperatus* L. was first questioned by Vainio (1886), who discovered a specimen of *Cetraria pinastri* (Scop.) S. F. Gray in the packet labeled *Lichen caperatus* in the Linnaean Herbarium. He assumed that this was the type specimen and therefore used the epithet *caperatus* for the *Cetraria* species, reduced *pinastri* to synonymy, and resurrected the Acharian var. *cyliphora* as the valid name for *P. caperata* auct. A study of Linnaeus' original diagnosis (Sp. Pl. 1147, 1753), however, indicates that the type of *Lichen caperatus* is probably not to be found in the Linnaean Herbarium. Linnaeus based his species on old phrase-names by Royen, Guettard, Dillenius, and Morison. The type of one of these pre-Linnaean species must be selected as the lectotype of *Lichen caperatus*, an action which has never been taken. Both Dillenius (Hist. Musc. *pl. 25, fig. 97A, B*, 1741) and Morison (Hist. ox. 633, *pl. 7, fig. 1*, 1699) illustrate a broad lobed Parmelia apparently identical with *P. caperata* auct., not a narrow lobes species such as *Cetraria pinastri*.

Specimen examined: *Malme* 2156.

Reactions: Thallus K−, medulla K−, C−, KC+ rose, P+ orange-red, usnic and protocetraric acids present.

The specimen appears to be typical *P. caperata* except for the lack of soredia, a condition not unknown in North American plants.

38. Parmelia digitata Lynge, Ark. Bot. 13, No. 13:98, *pl. 3*, fig. 4. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2545, March 12, 1894 (S).

Range: Brazil, West Indies.

Reactions: Thallus K+ yellow, medulla K−, C+ light orange, KC+ deep orange, P−, atranorine and barbatic acid present.

Parmelia digitata belongs to the difficult and highly variable *P. laevigata* group. It has distinct marginal laciniae and lobules much as in *P. lobulifera* Degel. from North Carolina. A specimen from Jamaica (*Imshaug* 14910, MSC) is identical with Lynge's type.

39. Parmelia eciliata (Nyl.) Nyl. in Fournier, Mex. Pl. I:3. 1872.—Lynge, 1914, p. 72. PLATE 1

Parmelia crinita var. *eciliata* Nyl. Flora 52:291. 1869.

Type: Orizaba, Mexico, *Bourgeau* in 1865 (H).

Range: Argentina, Brazil, West Indies, Mexico.

Additional specimen examined: *Malme* 627.

Reactions: Thallus K+ yellow, medulla K+ yellow, C−, KC−, P+ pale orange, atranorine and stictic acid present.

The Malme collection compares well with Nylander's holotype in spore size and lobation, but has somewhat shorter cilia. The species is discussed more fully under *P. urceolata* Eschw. (see p. 37).

40. Parmelia fatiscens Lynge, Ark. Bot. 15, No. 1:1. 1917. PLATE 2

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme*, October 16, 1902 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine, protocetraric acid, and traces of usnic acid in the cortex.

This species is characterized by large coralloid outgrowths which cannot properly be classified as isidia or soredia, although they sometimes become sorediate or pustular-isidiate. These peculiar growths also occur in *P. fasciculata* Vain. from Colombia, which contains atranorine and protocetraric acid, and in an undescribed species from Liberia, Africa. Certain forms of *P. robusta* Degel. have an atypical formation of tiny sorediate laciniae which coalesce into fasciculate coralloid growths resembling those of *P. fatiscens*.

41. Parmelia flava Kremplh. var. **stellata** Lynge, Ark. Bot. 13, No. 13:150, *pl. 5, figs. 5, 6.* 1914.

Parmelia flavida Zahlbr. var. *stellata* (Lynge) Zahlbr. Cat. Lich. Univ. 6:137. 1929. *Parmelia flavida* is a new name for *P. flava* Kremplh. non Rebent.

Type: São João d'el Rey, Minas Gerais, Brazil, *Malme* 311, September 1, 1894 (S).

Range: Brazil.

Reactions: Thallus K−, medulla K−, C−, KC+ rose, P+ orange-red, usnic and protocetraric acids present.

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The holotype of *P. flava* Kremplh. (Serra da Piedade, Minas Gerais, Brazil, *Warming* 294, M), which Lynge did not examine, has much broader, obtuse lobes (1.5–2.0 mm. wide) than the new variety (0.8–1.0 mm. wide), but is otherwise similar in chemistry and gross appearance.

42. Parmelia flava var. subdichotoma Lynge, Ark. Bot. 13, No. 13:149, *pl. 5, fig. 7.* 1914.—Lynge, 1925, p. 88.

Parmelia flavida Zahlbr. var. *subdichotoma* (Lynge) Zahlbr. Cat. Lich. Univ. 6:137. 1929.

Type: São João d'el Rey, Minas Gerais, Brazil, *Malme* 310, September 1, 1894 (S).

Range: Brazil.

Additional specimen examined: Caldas, Minas Gerais, Brazil, *Henschen* in 1868 (UPS).

Reactions: As in *P. flava* var. *stellata* Lynge.

This variety can hardly be distinguished from var. *stellata*. We have no choice but to maintain both varieties, which seem to be distinct from var. *flavida*, until the range of variation of the species is more completely known.

43. Parmelia fragilis Lynge, Ark. Bot. 13, No. 13:123. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2365*, February 19, 1894 (S).

Range: Brazil.

Reactions: Thallus K+ yellow, medulla K—, C+ orange-red, KC+ deep orange-red, P—, atranorine and olivetoric acid present.

This plant is identical in every respect with *P. intercalanda* Vain. (syntype: *Lich. Bras. Exs.* 899, FH). This species is apparently the first of the section *Hypotrachyna* in which olivetoric acid has been demonstrated. Lynge suggests a similarity with *P. microblasta* Vain., which does have the same gross appearance but which differs quite significantly in having isidia and norstictic acid (K+ red).

44. Parmelia fungicola Lynge, Ark. Bot. 13, No. 13:129. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2438B, February 27, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K—, C+ rose, KC+ red, P—, atranorine present, gyrophoric acid suspected but not proved microchemically because of the scarcity of material.

At first glance *P. fungicola* seems no more than a small isidiate form of *P. coronata* Fée. The contaminating fungus on the underside is a conspicuous feature. Lynge erroneously gave the medullary reaction as K+ yellow and C—, an understandable mistake in view of the small size of the thallus.

45. Parmelia gracilis (Müll. Arg.) Vain. Ann. Acad. Soc. Faun. & Fl. Fenn. 7:55. 1890.—Lynge, 1914, p. 124.

Parmelia laevigata var. *gracilis* Müll. Arg. Rev. Mycol. 1:169. 1879.

P. confusula Zahlbr. Cat. Lich. Univ. 6:162. 1929. A new name for *P. gracilis* (Müll. Arg.) Vain., non Sprengel nec Müll. Arg.

Type: Boqueron de Bogotá, Colombia, *André* 923 bis, December 21, 1875 (G, holotype; US, isotype).

Range: Colombia, Brazil.

Additional specimens examined: *Malme* 2241, 2749.

Reactions: Thallus K+ yellow, medulla K+ reddish, C−, KC+ red, P+ pale orange, atranorine and unidentified substances present; the acetone extract is a thick pale orange crust.

Parmelia confusula Zahlbr. is antedated by *P. zahlbruckneri* Lynge, which is identical with the type of *P. gracilis* (Müll. Arg.) Vain. (see p. 38). A noteworthy feature of this saxicolous lichen, other than the peculiar chemical reactions, is the shiny, whitish gray upper cortex, often transversely cracked and infested by a small black fungus.

46. Parmelia hieronymi Lynge, Nyt Mag. Naturv. 62:88. 1925.

The specimen on which this species was based was destroyed at Berlin. I have seen no herbarium specimens agreeing with the original description.

47. Parmelia isidiophora Zahlbr. Sitzungsb. Akad. Wiss. Math. Naturw. (Wien) 111:420, *pl. 1*. 1902.—Lynge, 1925, p. 89.

Type: Botanical Garden, Rio de Janeiro, Brazil, *Hõhnel* 169 (not seen, but appears to be typical *P. caroliniana* Nyl. from Zahlbruckner's photograph).

Specimen examined: Caldas, Minas Gerais, Brazil, *Henschen* in 1868 (UPS).

The single Henschen collection, verified by Zahlbruckner, is typical *P. caroliniana* Nyl., a widespread corticolous species in North and South America (cf. Hale, 1959**a**, p. 17). The specimen contains atranorine and perlatolic acid.

48. Parmelia kamtschadalis (Ach.) Eschw. var. **americana** (Mey. & Flot.) Nyl. Ann. Sci. Nat. Bot., ser. 4. 11:215. 1859.—Lynge, 1925, p. 89.

Evernia americana Mey. & Flot. Verh. Kaiser Leopold Carol. Akad. Naturforsch. 19, suppl. 1:211. 1843.

Type: Tropical America (destroyed at Berlin).

Specimen examined: Serra da Itatiaia, Brazil, *Dusén*, May 1902 (UPS).

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

The material conforms with the accepted concept of *P. amerieana* (Mey. & Flot.) Mont., which differs from *P. cirrhata* Fr. in being isidiate. Both species are widespread in mountains of tropical regions.

Parmelia kamtschadalis (Ach.) Eschw. is a completely unrelated species in the section *Xanthoparmelia*.

49. Parmelia laceratula Nyl. Mem. Soc. Imp. Sci. Nat. Cherbourg 5:105. 1857.—Lynge, 1914, p. 100, *pl 3, fig. 3*.

Holotype: Burnet and Brisbane River, Australia, *Müller* (H).

Range: Australia.

Reactions: Thallus K+ yellow, medulla K−, C+ red, KC+ red, P−, atranorine and lecanoric acid present.

Parmelia laceratula is a synonym of *P. subflava* Tayl. (type: Van Diemen's Land, FH). The types of both species have peculiar coarse marginal isidia and no pseudocyphellae except on the receptacle of the apothecia. The Malme specimens (533 and 828) seen by Lynge have the same chemistry but are densely pseudocyphellate on the upper surface. They are closest to *P. riograndensis* Lynge (=*P.* cf. *bolliana* Müll. Arg. see p. 31), but the thallus is very fragile. Lynge gave an incorrect chemical test (C−) and failed to include the species with the other pseudocyphellate Amphigymnias.

50. Parmelia laongii Lynge, Ark. Bot. 13, No. 13:68, *pl. 1, fig. 3*. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2392*, February 21, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present; cilia K+ violet.

Parmelia laongii is a member of the *P. melanothrix* group (see p. —), closest to *P. argentina* Krempelh. but with smaller spores (8–10×16–18μ vs. 10–13×19–23μ) and cilia K+ violet.

51. Parmelia latissima Fée, Ess. Crypt. Suppl. 119, *pl. 38, fig. 4*. 1837.—Lynge, 1914, p. 41.

Type: American tropics and Jamaica (not seen but well illustrated in color by Fée).

Range: Tropical regions.

Specimen examined: *Malme* 2742B. Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

Only this one Malme specimen seems to be typical *P. latissima*. Four other specimens examined by Lynge (*Malme* 2364, February 21, 1894, June 15 and June 25, 1894) contained atranorine and protocetraric acid and should be identified as *P. zollingeri* Hepp, a widespread tropical and subtropical species, apparently much more common than *P. latissima*. Aside from chemical differences, *P. zollingeri* seems to have slightly smaller spores than *P. latissima* (18–24μ vs. 28–32μ, both with the episporium 3–4μ wide).

52. Parmelia latissima var. corniculata Kremplh. Flora 61:463. 1878.—Lynge, 1914, p. 44.

Holotype: Argentina, *Lorentz & Hieronymus* (M).
Range: Argentina, Brazil.
Additional specimens examined: *Malme* 2738, 2743B, 2512Ba.
Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine and protocetraric acid present.

The specimens seen by Lynge correspond perfectly to Krempelhuber's original type. The K− reaction was overlooked by Lynge. If we should follow a strict chemical criterion, var. *corniculata* should be transferred to *P. zollingeri*, which also contains protocetraric acid. However, a formal recombination of the varietal name would be premature at this time, when the differences between *P. latissima* and *P. zollingeri* are so poorly understood.

53. Parmelia latissima f. microspora Lynge, Ark. Bot. 13, No. 13:45. 1914.

Lectotype: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2244*, January 19, 1894 (S).
Additional specimen examined: *Malme* 2244.
Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Both of the specimens identified by Lynge are the same as *P. wainii* A. L. Smith (see p. 29, under *P. proboscidea*). He described the form in part on the basis of a faulty color test, the medulla supposedly K+ yellow changing to red but actually K−.

54. Parmelia latissima var. minima Lynge, Ark. Bot. 13, No. 13:45. 1914.

Holotype: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2243C**, January 20, 1894 (S).
Range: Known only from the type locality.
Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine and protocetraric acid present.

Lynge at first described this plant as a new species, "*P. sublatissima*," in the herbarium. It is a much smaller plant than *P. latissima*, although otherwise comparable in morphology, and contains protocetraric acid, more characteristic of *P. zollingeri* Hepp. We cannot validly judge this new variety on the basis of a single small specimen.

55. Parmelia leucoxantha Müll. Arg. Flora 64:85. 1881.—Lynge, 1914, p. 82.

Type: Apiahy, Brazil, *Puiggari* 1050, March 1880 (G).
Range: Brazil.
Additional specimen examined: *Malme*, April 25, 1894.
Reactions: Thallus K+ yellow, medulla K−, C−, KC+ rose, P+ orange-red, atranorine, protocetraric acid, and usnic acid present.
Hillmann (1939) considered Lynge's determination to be incorrect.

Müller's type consists of four or five pieces of lichen pasted on a single card. The bulk of the material is identical with Malme's plant in chemistry and morphology, but the largest piece is a mixture of *P. leucoxantha* and another very similar species, apparently *P. nylanderi* Lynge (see p. 25), which has cilia and reacts K+ red (salacinic acid). It is probably this aberrant thallus on which Vainio (1900) based his K+ red reaction and report of sparse cilia. The K— eciliate material, equivalent to Lynge's concept, should be designated as the lectotype of *P. leucoxantha*.

56. Parmelia lindmanii Lynge, Ark. Bot. 13, No. 13:74. 1914. PLATE 3

Holotype: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 450, September 25, 1892 (S).

Range: Southern United States, Mexico, West Indies, Central and South America, Africa.

Reactions: Thallus K+ yellow, medulla K+ yellowish, C—, KC+ yellowish, P—, atranorine and an unidentified pale orange-yellow pigment (in the medulla) present.

This distinct species has a wide distribution in the tropics, yet it has almost always been misidentified in herbaria as *P. sulphurata* Nees & Flot. or *P. tinctorum* Nyl. (see Hale, 1959, p. 20). The pale yellowish pigment, also known in *P. merrillii* Lynge (p. 24) and *P. cornuta* var. *crocea* Lynge (p. 12), forms a long streak on chromatographic paper with butanol as a solvent. In contrast, vulpinic acid, which has a deeper lemon-yellow color, rises up the paper without any streaking. A chromatographic test is often necessary to separate the species from *P. sulphurata*.

57. Parmelia longiconida Lynge, Ark. Bot. 13, No. 13:130, *pl. 3, figs. 7, 8*. 1914.—Lynge, 1925, p. 89.

Holotype: Near Río Apa, Colonia Risso, Paraguay, *Malme* 1949, October 21, 1893 (S).

Range: Paraguay, Brazil.

Reactions: Thallus K+ yellow, medulla K+ yellow, C—, KC—, P+ orange, atranorine and stictic acid present.

This species is conspecific with *P. scrobicularis* Kremplh. from Brazil (holotype: Lagoa Santa, *Warming*, M). Two unusual characters are the pruinose apothecia, very rare in *Parmelia*, and the strongly reticulately rugose upper cortex. *Parmelia sbarbaronis* B. de Lesd. (Hale, 1959a, p. 23) differs only in having soredia and shorter conidia.

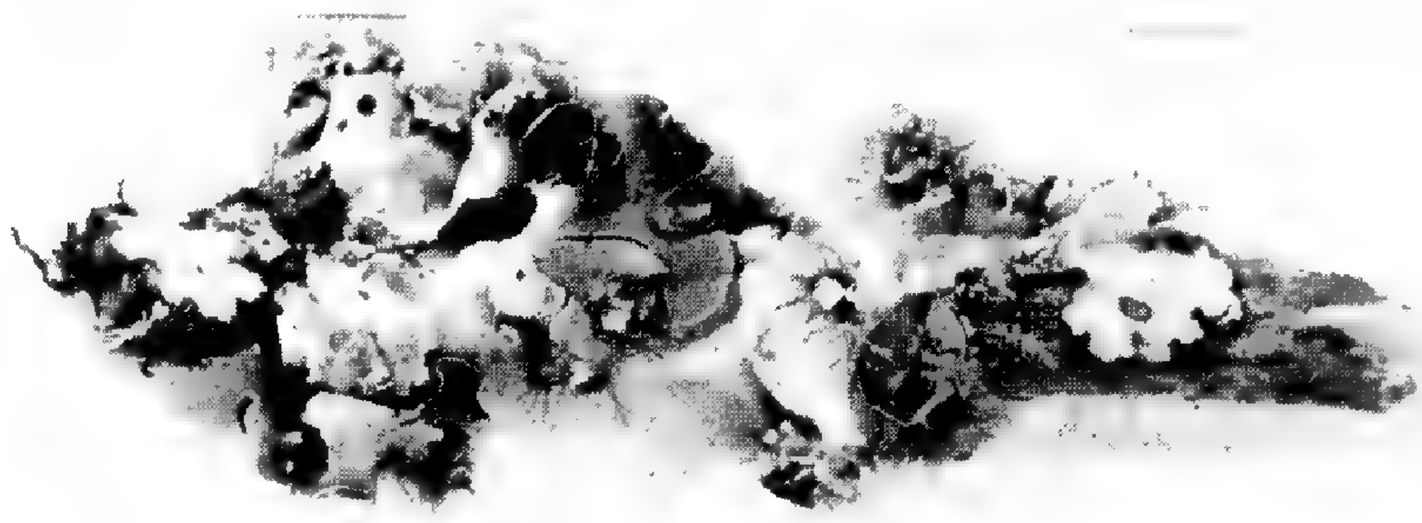
58. Parmelia magna Lynge, Ark. Bot. 13, No. 13:83. 1914.—Lynge, 1925, p. 89.

Holotype: São João d'el Rey, Minas Gerais, Brazil, *Malme* 269, August 31, 1892 (S).

Range: Brazil.

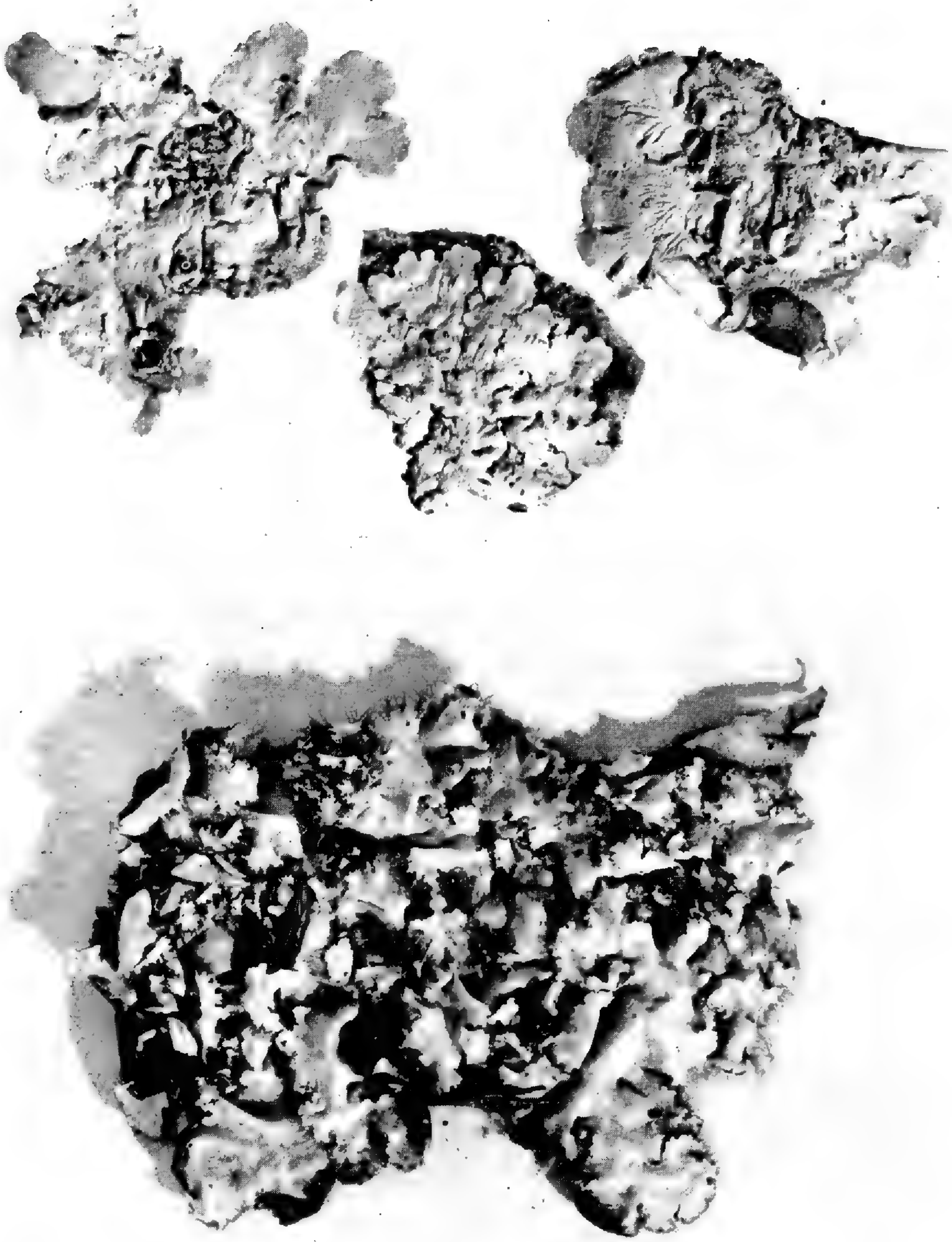
Parmelia eciliata (Nyl.) Nyl.
(Holotype)

Mat. chim.: Atranorine, stictic acid.
Examined by Mason E. Hale, Jr., U. S. National Museum III.1958

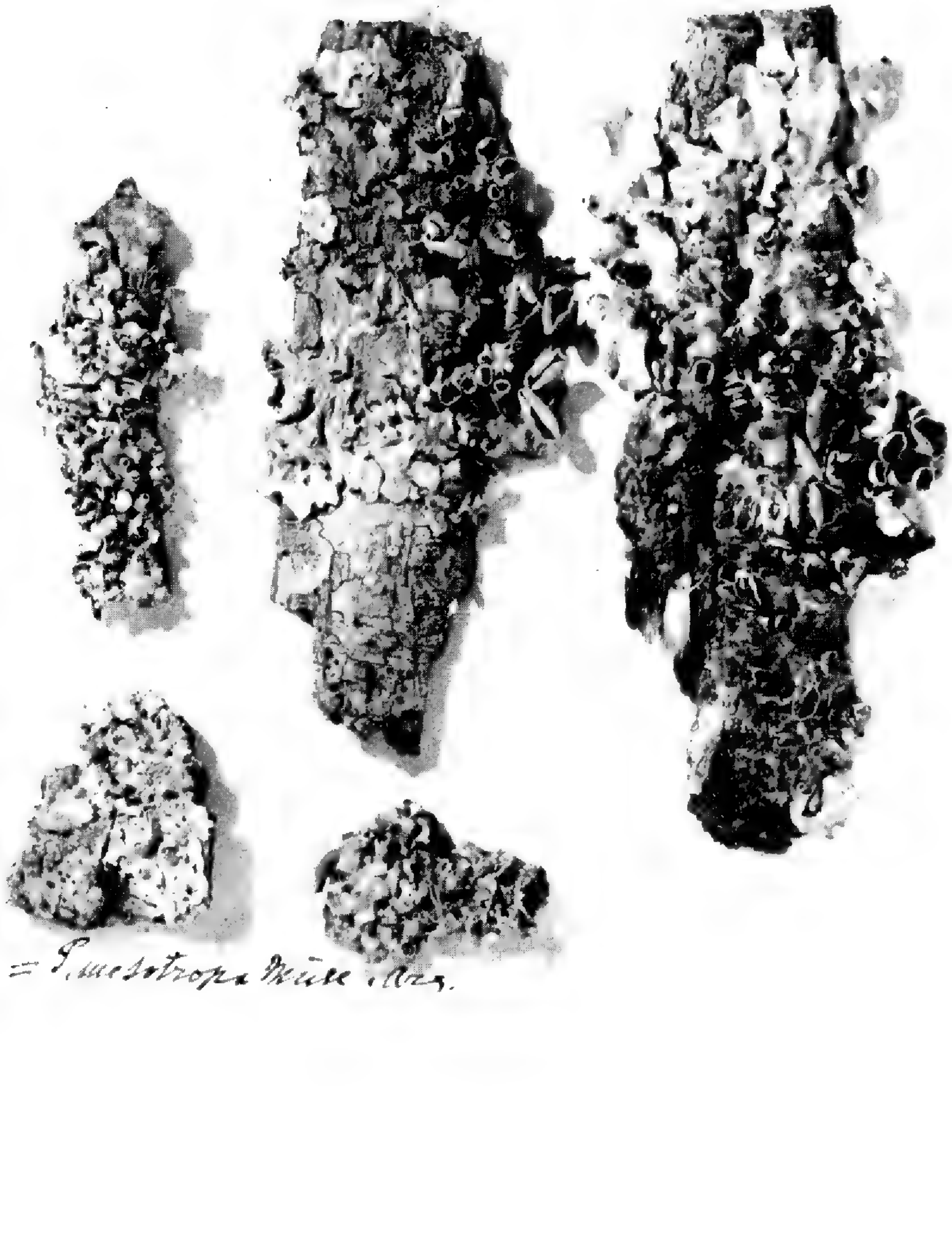


Above: *Parmelia acanthifolia* Pers. (holotype, *Gaudichaud* 13, P). Below: *Parmelia eciliata* (Nyl.) Nyl. (holotype, *Bourgeau*, H).

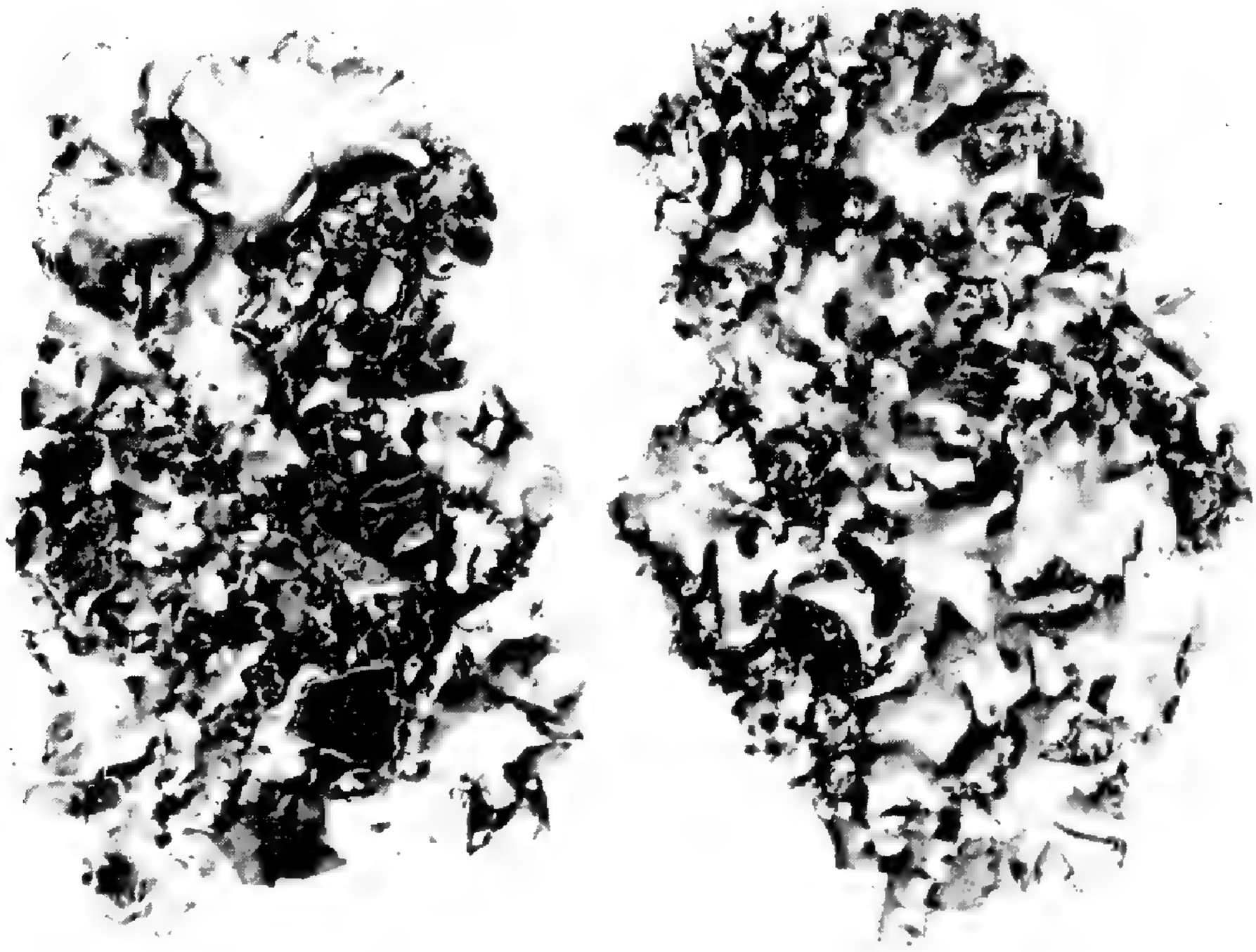
Parmelia fatiscens Lynge (holotype, *Malme*, S).



Above: *Parmelia lindmanii* Lynge (holotype, *Malme* 450, S). Below: *Parmelia proboscidea* var. *ornatula* Zahlbr. (holotype, *Damazio* 1090, G).



Parmelia mesotropa Müll. Arg. (lectotype, *Balansa*, G).



DER MÜLLER ARG. 1895

Above: *Parmelia sancti-angelii* Lynge (holotype, *Malme*, S). Below: *Parmelia bicornuta* Müll. Arg. (holotype, *Leyland*, G).

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine, salacinic and usnic acids present.

Parmelia magna is a large lichen, lacking isidia and soredia, with wide rotund, monophyllous lobes that easily break away from the main thallus. It is distantly related to *P. flavescens* (Krempelh.) Nyl.; its relation to other species with usnic acid may be illustrated in the following key:

1. Thallus isidiate; medulla K+ red or K−.
   2. Medulla K+ red (salacinic acid) . . . . **P. flavescens** (Krempelh.) Nyl.
   2. Medulla K−.
      3. Medulla C−, KC+ rose . . . . **P. madagascariacea** (Hue) des Abb.
      3. Medulla C+ rose (gyrophoric acid) or C−, KC−.
         P. xanthina (Müll. Arg.) Vain. (see p. 38)
1. Thallus without isidia; medulla K+ red (salacinic acid).
   4. Thallus fragile; lobes breaking apart . . . . . **P. magna** Lynge
   4. Thallus not fragile; lobes intact.
      5. Lobes elongate, conspicuously ciliate.
         P. radians Lynge (=*P. delicatula* Vain., see p. 29)
      5. Lobes short, more or less imbricate, cilia very sparse.
         P. microdactyla Hale (see p. 21)

A second specimen identified by Lynge as *P. magna* (Rio de Janeiro, *Widgren*, UPS) is a different plant, here proposed as a new species:

Parmelia microdactyla sp. nov.

Thallus laxe adnatus, 8–10 cm. latus, dilute flavescens, irregulariter lobatus, lobis 8–12 mm. latis, 10–15 mm. longis, nonnihil imbricatus, superne planus, laevigatus, nec isidiatus, neque sorediatus, margine integro vel plus minusve dactyloideo-lobulato, lobulis discretis, seriatis, 0.2–0.4 mm. latis, 0.4–0.6 mm. longis, parce ciliato, ciliis usque ad 0.5 mm. longis, medulla alba, subtus niger et rhizinosus, ambitum versus castaneus, glaber. Apothecia ignota; pycnidia numerosa, conidiis 6 μ longis. Thallus KOH−, medulla KOH+ rubra, C−, KC−, P+ aurantiacus, acidum salacinicum et acidum usnicum continens.

Type in the Botanical Museum of the University of Uppsala, collected by Widgren, Rio de Janeiro, Brazil; isotype in the Riksmuseum, Stockholm.

This new species is closest to the isidiate *P. flavescens*, but the isidia are replaced by peculiar marginal lobules. Zahlbruckner unnecessarily complicated the nomenclature of this group when he was revising the South American collections of Schiffner and Wettstein. Krempelhuber had described *P. glaberrima β flavescens*, which Nylander raised to species rank in 1885. Although Nylander actually saw an isotype of *P. glaberrima β flavescens* when he made the new combination, Zahlbruckner followed Vainio (1896, p. 33) in the belief

that "*P. flavescens* Nyl." was based on a gray, not a yellow specimen. Of course it is immaterial whether Nylander applied the new combination to a correctly identified plant or not. The holotype of *P. glaberrima β flavescens*, while not as yellow as typical *P. xanthina* (Müll. Arg.) Vain., does contain usnic acid. Following his own peculiar rules of nomenclature, Zahlbruckner wanted to make the combination "*P. flavescens* Zahlbr.," but since this name was preoccupied by "*P. flavescens* Nyl.", he had to propose a new name, *P. protoflavescens*. For the supposedly gray plant seen by Nylander, he proposed the name *P. pseudoflavescens*, which is no more than a nomen nudum. The synonymy is summarized below:

Parmelia flavescens (Kremplh.) Nyl. Flora 68:607. 1885.

P. glaberrina β flavescens Kremplh. Flora 52:223. 1869. Type: Rio de Janeiro, Brazil, *Glaziou* (M).

P. protoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. Illegitimate name.

P. pseudoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. Nomen nudum.

59. Parmelia malmei Lynge, Ark. Bot. 13, No. 13:116, *pl. 2, figs. 3, 4.* 1914.

Holotype: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2750, June 5, 1894 (S).

Range: Brazil.

Reactions: Thallus K−, medulla alba K−, C−, KC+ rose, P+ orange-red, medulla crocea K+ purple, lichexanthone, protocetraric acid, and an unidentified anthraquinone present.

Differing only in the greater development of pustules, this species falls within the morphological and chemical range of *P. minima* Lynge (see p. 25) and should be considered synonymous with it. The species has some affinity with *P. formosana* Zahlbr. (Hale, 1958b, p. 89), a larger plant which also contains lichexanthone (but not protocetraric acid) and has similar pustular outgrowths.

60. Parmelia marginalis Lynge, Ark. Bot. 13, No. 13:112. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2393****, February 21, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Parmelia marginalis adds yet another element of variability to the already large and difficult group of isidiate species in the section *Hypotrachyna*. It is characterized by an ashy white thallus (as opposed to the buff hue of the *P. minarum* group). It resembles *P.*

hookeri Tayl. (C+ red, lecanoric acid) rather closely, but it should not be classified merely as a chemical strain of that species.

61. Parmelia melanothrix (Mont.) Vain. Ann. Soc. Faun. & Fl. Fenn. 7:30. 1890.—Lynge, 1914, p. 54; 1925, p. 90.

Parmelia urceolata var. *melanothrix* Mont. Ann. Sci. Nat. Ser. II, Bot. 2:372. 1834.

Type: Brazil, *Gaudichaud* 89 bis (not seen); Vainio apparently saw the type in the Paris Museum and found it to react KC—.

Range: Tropical regions.

Specimens examined: *Malme* 201, 314, 967 (S); *Glaziou* 1835; Caldas, Minas Gerais, Brazil, *Henschen* in 1868; *Regnell*, s.d.; Brazil, *Guillemin* 127; and Rio de Janeiro, *Warming* (UPS). Reactions: Thallus K+ yellow, medulla K—, C—, KC—, P—, atranorine and an unknown fatty substance present.

Parmelia melanothrix belongs to a small, well-circumscribed group of primarily tropical species which have a white-maculate cortex, marginal cilia, and a pale zone below at the margin contrasting with the black rhizinate center. Its relationship to the other species of this group in the Western Hemisphere is shown in the following key:

1. Margins sorediate; apothecia unknown . . . . . **P. hypotropa** Nyl.
1. Soredia lacking; apothecia invariably present.
   2. Apothecia perforate.
      3. Salacinic acid present; spores 5–7 × 8–10 μ . **P. uruguensis** Kremplh.
      3. Norstictic acid present; spores 7–8 × 12–14 μ.
         P. perforata (Jacq.) Ach.
   2. Apothecia imperforate.
      4. Medulla KC–; spores 10–12 × 24–26 μ; episporium 3 μ.
         P. melanothrix (Mont.) Vain.
      4. Thallus KC+ red, alectoronic acid present; episporium less than 2 μ.
         5. Cilia K—.
            6. Thallus membranaceous; spores 6–7 × 17–19 μ.
               P. argentina Kremplh.
            6. Thallus rigid, covered with large apothecia; spores (after Lynge) 12–13 × 17–24 μ . . . . . **P. rigida** Lynge (see p. 31)
         5. Cilia K+ violet.
            7. Apothecia eciliate or at most sparsely ciliate, pale buff below at the margin; spores 6–8 × 11–14 μ.
               P. subproboscidea Lynge (see p. 35)
            7. Apothecia ciliate, tinged below pale reddish-orange; spores 8–10 × 16–18 μ . . . . . **P. laongii** Lynge (see p. 18)

Two additional specimens identified by Lynge as *P. melanothrix* (*Malme* 2522F* and February 19, 1894) reacting KC+ red (not KC— as reported by Lynge) are typical *P. argentina* Kremplh. (holotype: Argentina, *Lorentz & Hieronymus*, M).

62. Parmelia melanothrix f. microspora Lynge, ad int., Ark. Bot. 13, No. 13:56. 1914.

Lectotype: Villa Morra, Asunción, Paraguay, *Malme* 1585C, August 14, 1893 (S).

Additional specimens examined: *Malme*, September 3 and September 7 (two packets), 1893.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

As a new form "ad interim," this entity has no taxonomic status. The spores are smaller than those of typical *P. melanothrix*, and the chemical reaction as given by Lynge (KC−) is incorrect. This combination of morphological and chemical characters is found in *P. subproboscidea* Lynge (see p. 35), with which the Malme specimens are identical. A fourth specimen (*Malme*, September 3, 1893) is too fragmentary for verification.

63. Parmelia merrillii Lynge, Ark. Bot. 13, No. 13:79. 1914.

Parmelia lyngeana Zahlbr. Cat. Lich. Univ. 6:243. 1929. A new name for *P. merrillii* Lynge, non Vainio, Phil. Journ. Sci. 4:658. 1909.

Holotype: Coxipó Igreja, near Cuyabá, Mato Grosso, Brazil, *Malme* 2198B, December 27, 1893 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ yellowish, P−, atranorine and an unidentified pale orange-yellow pigment (in the medulla) present.

The species is very close to *P. cornuta* var. *crocea* Lynge (see p. 12) in morphology and chemistry, but the type material (the only collection of the species) is in poor condition.

64. Parmelia microsticta Müll. Arg. Flora 62:164. 1879—Lynge, 1914, p. 24; 1925, p. 90.

Parmelia borreri var. *allophylla* Krempih. Flora 61:438. 1878. Type: Argentina, *Lorentz & Hieronymus* (M).

Type: Montevideo, Uruguay (not seen).

Additional specimens examined: *Malme* 940, January 25, 1893; June 1893; September 11 and 13, 1894.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

This pseudocyphellate species is distinguished by a rigid thallus and a negative C reaction. It is otherwise similar to *P. bolliana* Müll. Arg.

64a. Parmelia microsticta var. **riograndensis** (Lynge) Lynge, Nyt Mag. Naturv. 62:90. 1925.

This combination was based on *P. riograndensis* Lynge, which is discussed on p. 31.

65. Parmelia minarum Vain. Ann. Soc. Faun. & Fl. Fenn. 7:48. 1890.—Lynge, 1914, p. 106.

Type: Sitio, Minas Gerais, Brazil, *Vainio* 1040 (FH, isotype).

Range: Central and South America, West Indies, Africa.

Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

The specimen identified by Lynge (*Malme* 2243) cannot be referred to *P. minarum*. It is a large plant with marginal cilia, twice the size of typical *P. minarum*, although both entities contain atranorine and gyrophoric acid. This is in all probability a new species, which I would hesitate to describe from the single collection.

66. Parmelia minima Lynge, Ark. Bot. 13, No. 13 : 139, *pl. 5, figs. 3, 4.* 1914.

Lectotype: Near Bocca da Serra, Mato Grosso, Brazil, *Malme* 2747 bis, June 15, 1894 (S).

Range: Brazil.

Additional specimens examined: *Malme* 2747, s.n.

Reactions: Thallus K−, medulla alba K−, C−, KC+ rose, P+ orange-red, medulla crocea K+ purple, lichexanthone, protocetraric acid, and an unidentified anthraquinone present.

Lynge's "originaleksemplar" is an intimate mixture of an ashy white plant with sorediate pustules and a yellowish one with isidia. His Latin description includes the morphological and chemical characters of the ashy plant and the external color of the yellowish plant. There is no doubt that the ashy plant should be the lectotype of *P. minima*, of which *P. malmei* Lynge is probably a synonym (see p. 22). The yellowish plant is too fragmentary for identification.

67. Parmelia nylanderi Lynge, Ark. Bot. 13, No. 13:82. 1914.

Holotype: Near São Jeronymo, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2747, June 3, 1894 (S).

Range: Brazil.

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine, salacinic acid, and usnic acid present.

This saxicolous species may be related to *P. leucoxantha* Müll. Arg. (see p. 19), which contains protocetraric acid and lacks cilia.

68. Parmelia olivaria Hue, Lich. Extra-Europ. 195. 1899.—Lynge, 1925, p. 91.

The specimen from Argentina so identified by Lynge was destroyed at Berlin.

69. Parmelia osseo-albida Lynge, ad int., Ark. Bot. 13, No. 13 : 133. 1914.

Lectotype: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 595, October 15, 1892 (S).

Additional specimen examined: *Malme* 1330B.

Reactions: Thallus K+ yellow, medulla K+ reddish, C−, KC+ red, P+ pale orange, atranorine and unidentified substances present; the acetone extract is a pale orange crust.

This species, which must be rejected since it was proposed provisionally, differs from *P. zahlbruckneri* Lynge (see under *P. gracilis*, p. 17) in having more irregular lobing and a looser attachment to the rock substratum. Considering that the plants share an unusual chemistry, I do not believe that the slight morphological variation constitutes a valid specific difference. As a matter of fact, in his key Lynge separated *P. osseo-albida* ("medulla KOH non coloratur") from both *P. gracilis* and *P. zahlbruckneri* ("medulla KOH rubescens") by a simple error: The medullary reaction of *P. osseo-albida* is given in the diagnosis (p. 134) as "intus e flavo rubescens."

70. Parmelia pachyderma Hue, Lich. Extra-Europ. 137, *pl. 4, figs. 1, 2.* 1899.—Lynge 1914, p. 137; 1925, p. 91.

Type: Montevideo, Uruguay, *Dr. Courbon* 536 (not seen).

The specimen identified by Lynge (*Malme* 1320) is identical with *Parmelia fistulata* Tayl. (syntypes: Argentina, *Tweedie*, and Montevideo, Uruguay, *Darwin*, FH). Zahlbruckner (1929, p. 60) inexplicably reduced it to a variety of *P. cirrhata* Fr. The two syntypes, however, differ significantly from *P. cirrhata* in having protocetraric acid and atranorine, rather than salacinic acid, and a beautifully effigurate white-maculate cortex. Judging from illustrations of the types, Hue's long-accepted name *P. pachyderma* and *P. felipponei* Lindau should be placed in synonymy under *P. fistulata*.

71. Parmelia palmarum Lynge, ad. int., Ark. Bot. 13, No. 13:136. 1914.

Holotype: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2243C*, January 20, 1894 (S).

Since Lynge proposed this new species "ad interim" and did not definitely accept it, it must be rejected. It is nevertheless a valid species, which may be characterized as follows, the description compiled from Lynge's original diagnosis of *P. palmarum:*

Parmelia palmarum Lynge

Parmelia palmarum Lynge, ad int., Ark. Bot. 13, No. 13:136, cf. *pl. 4, figs. 1, 2.* 1914.

Thallus laxe adpressus, mollis, cinereus vel vix flavescens, laciniis non bene radiantibus, 1–2 mm. latis, contiguis vel vulgo imbricatis, transversim rugosis, di- vel trichotomiter lobatis et crebre divergenter ramosis, lacinulis truncatis vel rotundatis et crenulatis, centrum versus lacinulis secundariis numerosis, parvis, digitatim vel coralliformiter ramosis, sorediis, isidiis et ciliis deficientibus, subtus niger, ad apicem anguste castaneus, usque ad ambitum rhiziniis nigris, ramosis, sat dense instructus. Cortex superior 20–25 μ altus, medulla

alba, 80–150 μ alta, cortex inferior fuscus vel fusconiger, 13–15 μ altus. Apothecia numerosa, diam. 5–6 mm., sessilia, non perforata, disco flavofuscente, subopaco, non pruinoso; hymenium superne fuscescens, ceterum decolor, 50–55 μ; sporae anguste limbatae, ovales, 9.5–11 μ longae, 5.3–6.6 μ crassae; conceptacula pycnoconidiorum subglobosa, 100–160 μ alta, 100–110 μ lata, conidiis 4–5 μ longis. Thallus K+ flavescens, medulla K−, C−, KC+ roseus, P−, atranorinum et materiam ignotam continens.

Type in the Naturhistoriska Riksmuseum, Stockholm, collected at Buriti, Serra da Chapada, Mato Grosso, Brazil, by G. A. Malme, No. 2243C*, January 20, 1894.

This species is a close relative of *P. livida* Tayl. (type: New Orleans, *Hook. Herb.*, FH), a common corticolous lichen in the southeastern United States with identical external appearance, although the thallus is more ashy white, and a similar KC+ reaction; *P. livida* differs principally in having smaller spores, 7–8 μ long, uniseriately arranged in the asci. *Parmelia bahiana* Nyl. could easily be confused with *P. palmarum*, except that it has a dense mat of rhizines projecting beyond the margins of the lobes. Lynge's "originaleksemplar" of *P. zahlbrukneri* (see p. 38) and one collection of *P. regis* Lynge (see p. 30) are both referable to *P. palmarum*.

72. Parmelia paraguariensis Lynge, Ark. Bot. 13, No. 13:71, *pl. 1, fig. 7.* 1914.

Holotype: Cierro Negro, Paraguari, Paraguay, *Malme* 1539, August 8, 1893 (S).

Reactions: Thallus K+ yellow, medulla K−, C+ red, KC+ red, P−, atranorine and lecanoric acid present.

This species is conspecific with *P. africana* Müll. Arg. (lectotype: Ghattas, Djur, Africa, *Schweinfurth* in 1877, G), a rather widespread species in Africa. A diagnostic character, aside from the unexpected occurrence of lecanoric acid, is the white-maculate upper cortex. *Parmelia rissoensis* Lynge (see p. 31) is merely a poorly developed specimen of this same species.

73. Parmelia perforata (Jacq.) Ach. Meth. Lich. 217. 1803.—Lynge, 1925, p. 91.
Lichen perforatus Jacq. Coll. Bot. 1:116, *pl. III.* 1786.

Type: Pennsylvania; not seen, but the original specimen is well illustrated in the color plate by Jacquin.

Range: Southeastern United States.

Lynge determined two packets as *P. perforata* (Caldas, Minas Gerais, Brazil, *Henschen* in 1868, UPS), but both are misidentified. One specimen is *P. subcaperata* Kremplh., and the other is *P. leucosemotheta* Hue, both of which contain atranorine and salacinic acid. *Parmelia perforata*, a species endemic to the United States, contains norstictic acid.

74. Parmelia persulphurata Nyl. *in* Cromb. Journ. Linn. Soc. London 16:219. 1877.—Lynge, 1914, p. 80.

Type: Not seen; the holotype was collected by Crombie in Bahia, Brazil. Nylander (Flora 68:606, 1885) later published the same diagnosis that he sent to Crombie in litt. and cited two specimens, from Cuba and Louisiana, which are the same as the holotype of *P. sulphurata* Nees & Flot. according to Hillmann (1939).

The Malme specimen (June 26, 1894) identified by Lynge lacks isidia and cannot therefore be *P. persulphurata* (if we are correct in assuming the latter species is synonymous with *P. sulphurata*). Actually it is closer to *P. cornuta* Lynge (see p. 12), but the material is far too poor for sound judgment.

75. Parmelia pluriformis Nyl. Synops. Lich. 381. 1858–60.—Lynge, 1925, p. 91.

Type: Minas Gerais, Brazil, *Weddell*, Nyl. Herb. No. 35585, (H).

Range: Brazil.

Additional specimen examined: São Paulo, Brazil, *Lindberg*, April 1854 (UPS).

Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Lynge reported his determination with doubt, but the material is fully typical.

76. Parmelia portoalegrensis Lynge, Ark. Bot. 13, No. 13:147, *pl. 5, fig. 13.* 1914.

Lectotype: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 571, October 15, 1892 (S).

Additional specimen examined: *Malme* 560.

Reactions: Thallus K−, medulla K+ yellow, C−, KC−, P+ light orange, usnic and stictic acids present.

The tropics abound in minute isidiate species of the section *Xanthoparmelia* Vain. One of the first to be described, *P. adpressa* Kremplh., must be rejected as an orthographic variant and later homonym of *P. appressa* Mey. & Flot. The holotype of *P. adpressa* (Rio de Janeiro, *Glaziou* 3842, M) contains usnic acid and stictic acid and appears in other respects to be typical *P. isidiata* (Anzi) Gyel. Müller described a variety of this species, *P. adpressa* var. *stenophylloides* Müll. Arg., which Vainio raised to the rank of species as *P. stenophylloides* (Müll. Arg.) Vain. This entity also contains stictic acid but seems to be amply distinct from *P. isidiata* by reason of the very narrow lobes (to 0.5 mm wide). It has been suggested (cf. des Abbayes, 1958, p. 5) that *P. congensis* Stein., published in 1889, is identical with *P. stenophylloides* and should be the correct name for this entity. I have not checked the type of *P. congensis*, an African species, but the description seems to conform to *P. stenophylloides*.

Parmelia portoalegrensis is hardly distinguishable from this narrow lobed entity, whatever its correct name, except for the more crowded, contiguous lobes, and is perhaps merely a growth form on very smooth rock faces. It should be considered provisionally as a synonym of *P. congensis*.

77. Parmelia proboscidea Tayl. *in* Mack. Fl. Hibern. 2:143. 1836.—Lynge, 1914, p. 38; 1925, p. 91.

Type: Dunkerron Mountains, Ireland (FH); conspecific with the earlier *P. crinita* Ach. (cf. Hale, 1958a, p. 179).

Reactions: Thallus K+ yellow, medulla K+ yellow, C−, KC−, P+ pale orange, atranorine and stictic acid present.

Lynge followed Müller and Vainio in an incorrect interpretation of Taylor's species. A. L. Smith, who was familiar with *P. proboscidea* from Great Britain and knew that it was simply *P. crinita*, realized that the tropical plants so named were a different species. She gave them a new name, *P. wainii* A. L. Smith (Journ. Linn. Soc. London, Bot. 46:85, 1922), and cited as a basionym *P. proboscidea* (*sensu* Vainio, Acta Soc. Faun. & Fl. Fenn. 7:29, 1890). Vainio's *Lich. Bras. Exs.* Nos. 400 (FH), 582B, 973, and 1000 are therefore syntypes of *P. wainii*. Two packets labeled *P. proboscidea* by Lynge (*Malme* 314B and June 15, 1894) are identical with *Lich. Bras. Exs.* 400. Zahlbruckner (1904, p. 135) had actually described this entity earlier as *P. proboscidea* var. *ornatula* Zahlbr. (holotype: Serra do Ouro Preto, *Damazio* 1090, G; plate 3). *Parmelia wainii* is characterized by an ample thallus, marginally ciliate and without soredia or isidia; it produces atranorine and alectoronic acid (KC+ red). At the present time it is known from Brazil and Africa.

78. Parmelia prolixa var. **rosea** Lynge, Nyt Mag. Naturv. 62:91. 1925.

The specimen on which Lynge based this new variety was destroyed at Berlin.

79. Parmelia radians Lynge, ad int., Ark. Bot. 13, No. 13:85. 1914.

Holotype: São João d'el Rey, Minas Gerais, Brazil, *Malme* 203, August 30, 1892 (S).

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine, salacinic acid, and usnic acid present.

Parmelia radians should be rejected as a provisional new species "ad interim." The type specimen is identical with *P. delicatula* Vain. (type: *Lich. Bras. Exs.* 1256, FH), although Lynge thought that Vainio's plant had a deeper yellow color than his own. The relation of *P. delicatula* to other tropical species with usnic acid in the section *Amphigymnia* is given in the key on p. 21.

80. Parmelia regis Lynge, Ark. Bot. 13, No. 13:126. 1914.

Lectotype: São João d'el Rey, Minas Gerais, Brazil, *Malme* 178, August 30, 1892 (S).

Range: Known only from the type locality.

Reactions: Thallus K—, medulla K+ wine-red, C—, KC+ pale red, P+ pale orange, lichexanthone and unidentified substances present.

The type of *P. regis* cannot be told externally from *P. silvatica* Lynge (see p. 34); it differs chiefly in lacking an anthraquinone pigment in the lower medulla. The two species are separated in Lynge's key (p. 21) by: "1. Thallus KOH superne non coloratur" (*P. silvatica*), and "2. Thallus superne flavescens" (*P. regis*). Lynge apparently established a yellow K test for *P. regis* from the two misidentified syntypes discussed below, since the "originaleksemplar" is K—. While *P. regis* thus delimited differs only in chemical characters from *P. silvatica*, it should be retained as a separate species until we are more familiar with the range of chemical variation in this group.

The other two specimens cited by Lynge (*Malme* 941 and 2393****) differ from the lectotype in lacking lichexanthone and reacting K+ yellow on the cortex and K— in the medulla. One specimen (2393****) is identical with *P. palmarum* Lynge (see p. 26 under *P. palmarum* Lynge), while the other, which Lynge had first called a new species in manuscript, *P. cachoeirae*, is too fragmentary for proper study.

81. Parmelia regnellii Lynge, Ark. Bot. 13, No. 13:140, *pl. 5, figs. 1, 2.* 1914.

Lectotype: São João d'el Rey, Minas Gerais, Brazil, *Malme* 308, September 1, 1892 (S).

Range: Brazil.

Additional specimens examined: *Malme* 179, 2748B, 2745B, s.n.

Reactions: Thallus K—, medulla alba K+ yellowish, C+ yellowish, KC+ orange-yellow, P— (P+ in 2745B), medulla crocea K+ purple, usnic and barbatic acids (stictic in 2745B), an unidentified anthraquinone and other substances present.

Parmelia regnellii is a most remarkable lichen with a deep yellow thallus and in part a deep saffron medulla. Although Malme collected the species at three widely separated localities, it has not appeared in the literature or been seen in herbaria since Lynge's description.

82. Parmelia regnellii f. **arida** Lynge, Ark. Bot. 13, No. 13:141. 1914.

Holotype: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil *Malme* 2240, January 21, 1894 (S).

Range: Known only from the type locality.

Reactions: As in *P. regnellii* f. *regnellii*.

This form is much smaller than the typical form but has a similar chemistry.

83. Parmelia revoluta Floerke, Deutsch. Lich. 1:11. 1815—Lynge, 1925, p. 92.

Lynge based his record on two small fragments (*Henschen* in 1868, UPS), which in my opinion are not identifiable. Although *P. revoluta* has appeared in several lists of tropical American Parmelias, I doubt that the identifications are correct.

84. Parmelia rigida Lynge, Ark. Bot. 13, No. 13:50, *pl. 2, fig. 2.* 1914.

Holotype: Piratiny, Rio Grande do Sul, Brazil, *Malme* 827B, December 17, 1892 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine, and alectoronic acid present.

The exceedingly rigid thallus without soredia or isidia and the numerous large apothecia set this species apart from all other parmelias. It may be placed in the *P. melanothrix* group (see. p. 23) because of the white-maculate cortex and the presence of alectoronic acid. Lynge mistakenly gave the medullary reaction as KC−.

85. Parmelia riograndensis Lynge, Ark. Bot. 13, No.13:26, *pl. 1, fig. 2.* 1914.
Parmelia microsticta Müll. Arg. var. *riograndensis* (Lynge) Lynge, Nyt Mag. Naturv. 62:90. 1925.

Lectotype: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 461, September 25, 1892 (S).

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

Additional specimen examined: *Malme* 1282B. Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Lynge based his description on two packets, one labeled "original-eksemplar," reacting C+ rose, which was erroneously designated by me (1958a, p. 180) as the holotype, and another reacting C−, which is the legitimate lectotype since it agrees with Lynge's C test. The two chemical strains are morphologically indistinguishable and near, if not equal to, *P. bolliana* Müll. Arg., which has the same chemical strains in the southwestern United States (Culberson & Culberson, 1956). A fuller understanding of *P. riograndensis* will depend on further study of *P. microsticta* Müll. Arg. and *P. squamuligera* Sant., but provisionally it can be regarded as a synonym of *P. bolliana*.

86. Parmelia rissoensis Lynge, Ark. Bot. 13, No. 13:69. 1914.

Holotype: Near Río Apa, Colonia Risso, Paraguay, *Malme* 1895B, October 7, 1893 (S).

Reactions: Thallus K+ yellow, medulla K−, C+ red, KC+ red, P−, atranorine and lecanoric acid present.

This entity is conspecific with *P. africana* Müll. Arg. and a poorly developed state of its synonymous species, *P. paraguariensis* Lynge (see p. 27).

87. Parmelia rudecta Ach. Syn. Lich. 197. 1814.—Lynge, 1914, p. 29; 1925, p. 92.

Type: North America, *Muhlenberg* (PH, isotype).

Reactions: Thallus K+ yellow, medulla K−, C+ red, KC+ red, P−, atranorine and lecanoric acid present.

Additional specimens examined: *Malme*, July 9, 1894; *Glaziou* 1834 (UPS). Both of these specimens contain gyrophoric acid (C+ rose).

The specimens are identical in morphology with the typical North American *P. rudecta*, which produces lecanoric acid constantly (Culberson & Culberson, 1956). The significance of the chemical difference in South American specimens has not yet been evaluated.

88. Parmelia rupicola Lynge, Ark. Bot. 13, No. 13:132, *pl. 3, figs. 5, 6.* 1914.

Holotype: Porto Alegre, Rio Grande do Sul, Brazil, *Malme*1339, June 2, 1893 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and divaricatic acid present.

Parmelia rupicola mimics the crustose *Lecanora muralis* (Schreb.) Rabh. very closely in size and habit. Divaricatic acid is known in only one other *Parmelia* species, *P. texana* Tuck, a widely distributed corticolous species in temperate and tropical regions.

89. Parmelia rupta Lynge, Ark. Bot. 13, No. 13:40. 1914.

Holotype: Río Negro, Gran Chaco, Paraguay, *Malme*, September 14, 1893 (S).

Range: Known only from the type locality.

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC−, P+ orange-red, atranorine and salacinic acid present.

The single holotype collection has the appearance of *P. cetrata* Ach. with a reticulately rimose cortex. However, it has a rather distinct naked zone below at the margins. The species cannot be evaluated from this single rather poor specimen.

90. Parmelia rutidota Hook. & Tayl. Lond. Journ. Bot. 3:645. 1844.—Lynge, 1914, p. 151; 1925, p. 92.

Type: Van Dieman's Land (FH).

Range: Australia, South America.

Reactions: Thallus K—, medulla K—, C—, KC+ rose, P+ orange-red, usnic and protocetraric acids present.

Additional specimen examined: *Malme* 715.

The Malme specimen has the same morphology, habit, and spore size (13–16 × 7–10 μ) as Taylor's type, but it contains fumarprotocetraric acid. It is probably no more than a chemical strain of little significance, and does not warrant species rank at this time. *Parmelia rutidota* is a plant of the southern hemisphere. Asahina's report from Japan (1952, p. 142) is a misidentified species of the *P. texana* group.

91. Parmelia rutidota f. filizans Lynge, Ark. Bot. 13, No. 13:153. 1914.

Holotype: Quinta, near Rio Grande, Rio Grande do Sul, Brazil, *Malme* 727, December 3, 1892 (S).

Range: Known only from the type locality.

Reactions: Thallus K—, medulla K—, C—, KC— or brownish, P+ red, fumarprotocetraric acid and usnic acid present.

This is a well characterized form with conspicuous filiform marginal laciniae.

92. Parmelia saccatiloba Tayl. Lond. Journ. Bot. 6:174. 1847.—Lynge, 1914, p. 65.

Lectotype: Pitcairn's Island, *Beechey* (FH, cf. Hale, 1958, p. 180).

Reactions: Thallus K+ yellow, medulla K—, C—, KC+ rose, P+ orange-red, atranorine and protocetraric acid present.

The five specimens thus identified by Lynge (*Malme* 1678**, 2156B, 2392**, s.n.) all contain atranorine and a fatty substance near caperatic acid, and lack the isidia characteristic of *P. saccatiloboa*. They may be identified as *P. mesotropa* Müll. Arg. (type: Asunción, Paraguay, *Balansa* in 1878, G, plate 4), a common species which Lynge failed to study.

93. Parmelia saccatiloba f. membranacea Lynge, ad int., Ark. Bot. 13, No. 13:67. 1914.

Holotype: Pilcomayo, Gran Chaco, Paraguay, *Malme*, September 2, 1893 (S).

Reactions: Thallus K+ yellow, medulla K—, C—, KC—, P—, atranorine and an unknown fatty substance near caperatic acid present.

This form, which is not validly published, is also identical with *P. mesotropa* Müll. Arg. The smaller spores as reported by Lynge probably have no significance.

94. Parmelia sancti-angelii Lynge, Ark. Bot. 13, No. 13:35. 1914.—Lynge, 1925, p. 92. PLATE 5

Holotype: Colonia Santo Angelo, near Cachoeira, Rio Grande do Sul, Brazil, *Malme*, January 25, 1893 (S).

Range: Mexico, West Indies, South America, Africa, China.

Additional specimens examined: Caldas, Minas Gerais, Brazil, *Henschen* in 1868 (UPS).

Reactions: Thallus K+ yellow, medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Parmelia sancti-angelii is a distinctive species now known to be widespread in tropical regions. In size and general morphology, it resembles *P. maxima* Hue (*P. claudelii* (Harm.) Vain.), which contains salacinic acid (K+ red). There is considerable variance in spore size, which is difficult to assess in a species so often collected sterile. Lynge reported spores 26–33 μ long with a wide episporium; other tropical collections which I have measured have much smaller spores, only up to 16 μ long, with a thin episporium. Differences of this magnitude are generally not expected.

95. Parmelia semilunata Lynge, Ark. Bot. 13, No. 13:23, *pl. 5, figs. 10–12.* 1914.

Holotype: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme*, June 19, 1894 (S).

Range: Known only from the type locality.

Reactions: Specimens too fragmentary for testing; Lynge reported the thallus K+ yellow, medulla C−, K−.

Externally *P. semilunata* could be mistaken for a species in the *P. coronata* group because of the small steel-gray thallus with coronate apothecia. The spores, however, are distinctly two-horned, a peculiar character known only in *P. schiffneri* Zahlbr. and *P. bicornuta* Müll. Arg., the latter species a much larger plant (plate 5) with lecanoric acid (type: Rio de Janeiro, *Leyland*, G). In view of the great morphological diversity of the three species it seems doubtful whether they should be joined together in a separate section of the genus (Section *Bicornutae* Lynge, Ark. Bot. 13, No. 13:23, 1914) solely on the basis of the unique spores.

96. Parmelia silvatica Lynge, Ark. Bot. 13, No. 13:118, *pl. 5, fig. 14.* 1914.

Lectotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2393*, February 21, 1894 (S).

Range: Brazil.

Additional specimens examined: *Malme*, March 3, 1894, June 25, 1894.

Reactions: Thallus K−, medulla alba K−, C−, KC+ rose, P+ orange-red, medulla crocea K+ purple, lichexanthone, protocetraric acid, and an unidentified anthraquinone present.

This well-circumscribed species is characterized by an unusual combination of chemical components. It is very near *P. regis* Lynge

(see p. 30), which lacks the pigment, and not far removed from species in the *P. bahiana-P. palmarum* group (see p. 26 under *P. palmarum* Lynge).

97. Parmelia silvatica var. pinnata Lynge, Ark. Bot. 13, No. 13:120. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2393***, February 21, 1894 (S).

Range: Known only from the type locality.

Reactions: As in *P. silvatica* var. *silvatica*.

This variety is a broader-lobed plant than var. *silvatica*. I doubt that it could be told from the typical variety in a larger series of specimens, and I therefore do not believe it deserves any taxonomic rank.

98. Parmelia silvatica var. radiata Lynge, Ark. Bot. 13, No. 13:120. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2393**, February 21, 1894 (S).

Range: Known only from the type locality.

Reactions: As in *P. silvatica* var. *silvatica*.

This variety differs from var. *silvatica* only in being more closely adnate to the bark, and in this respect it approaches *P. crustacea* Lynge (see p. 13) closely. I do not believe it deserves taxonomic status.

99. Parmelia soredica Nyl. Flora 68:608. 1885.—Lynge, 1925, p. 92.

A single specimen collected by Fries in Argentina (S) and cited by Lynge has not been available for study.

100. Parmelia subproboscidea Lynge, Ark. Bot. 13, No. 13:36. 1914.

Holotype: Assuncion, Paraguay, *Malme* 1678 in 1893 (S).

Range: Paraguay.

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present; cilia K+ violet.

Parmelia subproboscidea has no relationship at all with *P. proboscidea* Tayl. (= *P. crinita* Ach.) but is a member of the *P. melanothrix* group (see under *P. melanothrix*, p. 23). It differs from *P. laongii* Lynge in having slightly smaller spores and a paler underside. *Parmelia melanothrix* f. *microspora* Lynge (see p. 24) is referable to this species. The recognition of *P. subproboscidea* makes the typification of *P. urceolata* Eschw. (Icon. Pl. Crypt. 23, 1827) essential. Though Eschweiler's color plate is not as clear as we would like, there is a strong possibility that it is the same as *P. subproboscidea*. In any event, when the type of *P. urceolata* is located and studied, that name will doubtless replace one of those of the presently recognized members of the *P. melanothrix* group.

101. Parmelia subregressa Lynge, ad. int., Ark. Bot. 13, No. 13:58. 1914.
Parmelia subregressa, Lynge, Nyt. Mag. Naturv. 62:93. 1925.

Holotype: Paraguari, Paraguay, *Malme* 1525B, August 7, 1893 (S).

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and a fatty substance present.

Parmelia subregressa Lynge, "ad interim," dating from 1914, must be rejected as a provisional name. The holotype is identical morphologically and chemically with *P. mesotropa* Müll. Arg. (see p. 33, under *P. saccatiloba* Tayl.). In the second publication dating from 1925, Lynge listed the species without provisional status, so that this is the valid date of publication of *P. subregressa*. The specimen on which the second determination was based (Pampa Blanca, Argentina, *Fries*, S) has not been seen, but the type of the species would still be the Malme specimen.

102. Parmelia subrugata Krempl h. var. **arcuata** Lynge, Ark. Bot. 13, No. 13:48. 1914.

Holotype: Porto Alegre, Rio Grande do Sul, *Malme* 440, September 25, 1892 (S).

Reactions: Thallus K+ yellow, medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

The holotype of *P. subrugata* Krempl h. (Serra dos Orgãos, Minas Gerais, Brazil, *Helmreichen*, M) has more or less arcuate conidia such as Lynge described for his new variety. Since the two entities are completely similar in morphology and chemistry, var. *arcuata* may be regarded simply as a synonym of var. *subrugata*.

103. Parmelia sulphurata Nees & Flot. Linnaea 9:501. 1834.—Lynge, 1914, p. 75; 1925, p. 94.

Type: Destroyed at Berlin, but once examined by Hillmann (1939), who compared it with *P. persulphurata* Nyl. (see p. 28).

Range: Tropical regions.

Specimen examined: *Malme* 146. Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and vulpinic acid present.

Lynge's determination agrees with the present concept of the species. The density of isidia and marginal cilia varies widely.

104. Parmelia tinctorum Nyl. Flora 55:547. 1872.—Lynge, 1914, p. 32; 1925, p. 94.

Type: Nylander apparently based the species on a specimen from the Canary Islands collected by Despréaux (not seen).

Range: Cosmopolitan in tropical and subtropical regions.

Specimens examined: *Malme* 1889, 1895 Ac, 1480, 2369, 2243C, 196, and September 7, 1893. Reactions: Thallus K+ yellow, medulla K−, C+ red, KC+ red, P−, atranorine and lecanoric acid present.

Nylander should be cited as the author of this weedy tropical species, since Despréaux merely provided a specimen with an herbarium name.

105. Parmelia uleana Müll. Arg. Flora 72:506. 1889.—Lynge, 1914, p. 155, *pl. 4, fig. 6.*

Type: Nova Cintra, Rio de Janeiro, Brazil, *Ule* 10 (G).

Range: Southern United States, West Indies, Central and South America, and Africa.

Additional specimens examined: *Malme* 61 and August 16, 1894; *Malme* 91, 2366, 2418, 2435B, 2519, 2642, 2742, and June 16, 1894.

Reactions: Thallus K−, medulla K+ yellowish, C−, KC+ pale orange, P−, usnic and barbatic acids, and an unidentified yellowish pigment in the medulla present. The first two specimens cited contain stictic acid (P+ pale orange) instead of barbatic acid.

Parmelia uleana is a synonym of *P. sphaerospora* Nyl. (Hale, 1959a, p. 129), a very common tropical species distinguished by nearly spherical spores, a thick minutely rugulose cortex, and lack of soredia or isidia. The chemical composition is not perfectly clear at present.

106. Parmelia urceolata Eschw. Icon. Pl. Crypt. 23. 1827.—Lynge, 1914, p. 64; 1925, p. 95.

Type: Not seen, but illustrated by Eschweiler (see under *P. subproboscidea* Lynge, p. 35).

The two specimens determined by Lynge (*Malme* 827, and Zarati, Argentina, September 1894) contain atranorine and stictic acid and should be referred to *P. eciliata* (Nyl.) Nyl. (see p. 15).

107. Parmelia viridescens Lynge, Ark. Bot. 13, No. 13:117, *pl. 3, figs. 9, 10.* 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2453, February 28, 1894 (S).

Range: Known only from the type locality.

Reactions: Thallus K−, medulla K−, C−, KC−, P−, no lichen substances proved.

The type is a pale greenish plant without soredia or isidia. It resembles no other species known to me.

108. Parmelia wainioana Lynge, Ark. Bot. 13, No. 13:87. 1914.

Holotype: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2435C, February 27, 1894 (S).

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine and perlatolic acid present.

This species is synonymous with *P. caroliniana* Nyl., a common corticolous species from the southern United States southward to Brazil (Hale, 1959a, p. 17).

109. Parmelia xanthina (Müll. Arg.) Vain. Ann. Soc. Faun. & Fl. Fenn. 7:37. 1890.—Lynge, 1914, p. 85.

Parmelia proboscidea var. *xanthina* Müll. Arg. Flora 67:616. 1884.

P. perlata var. *xanthina* (Müll. Arg.) Stizb. Ber. St. Gall. Naturw. Gesell. 1888–1889:156.

Type: Central Madagascar, *Hildebrandt* (G).

Range: Brazil, Madagascar.

Reactions: Thallus K+ yellow, medulla K−, C−, KC−, P−, atranorine, and usnic and protolichesteric acids present.

Des Abbayes (1958, p. 21) gave considerable attention to the status of this species. Although he was unable to typify Müller's var. *xanthina* satisfactorily, he referrred plants reacting C− in the medulla to *P. aberrans* (Vain.) des Abb., and the plants reacting C+ rose to *P. xanthina* Vain. nec Müll. Arg. The latter citation is incorrect inasmuch as any new combination is based on the type of the basionym, regardless of whether the combining author saw it or not. A specimen labeled *P. perlata* var. *xanthina* Müll. Arg. which I received from Geneva and which I believe is the holotype of *P. proboscidea* var. *xanthina* reacts C−, as indicated above. Therefore, *P. aberrans* is only a synonym of *P. xanthina*. Plants reacting KC+ rose have been identified with *P. madagascariacea* (Hue) des Abb. (des Abbayes, 1958, p. 22), Plants reacting C+ rose, such as Vainio's *Lich. Bras. Exs.* 1181 and the two Malme specimens seen by Lynge (*Malme* 2748 and June 22, 1894) are indistinguishable from both *P. madagascariacea* and *P. xanthina* (C−) except for the C+ rose test caused by gyrophoric acid. I would prefer to rank the C+ plants as a chemical strain of *P. xanthina* for the present. It may be desirable to recognize them as a distinct species in the future when the whole *P. xanthina* group (see under *P. magna* Lynge, p. 20) has been more precisely delimited.

110. Parmelia zahlbruckneri Lynge, Ark. Bot. 13, No. 13:125, *pl. 4, figs. 1, 2.* 1914.

Lectotype: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme*, June 15, 1894 (S).

Reactions: Thallus K+ yellow, medulla K+ red, C−, KC+ reddish, P+ pale orange, atranorine, and unknown substances present. The acetone extract is a pale orange crust.

Parmelia zahlbruckneri was based on two specimens. The one labeled "Originaleksemplar" and photographed (*pl. 4, figs. 1, 2*) by Lynge (*Malme*, same data as the lectotype above) reacts K−, C−, KC+ rose in the medulla and is best referred to *P. palmarum* Lynge (see under *P. palmarum* Lynge, p. 26). The other syntype,

here designated the lectotype since it conforms better with the original diagnosis, is identical in every respect with *P. gracilis* (Müll. Arg.) Vain. Since *P. gracilis* is a later homonym and *P. confusula* Zahlbr., a new name, was published in 1929, *P. zahlbruckneri* becomes the correct name for this entity (see under *P. gracilis*, p. 17).

Summary of Synonymy, Misidentifications, and Changes in Nomenclature

Lynge identified a total of 110 taxa, 99 of which I have been able to verify. Of the 61 new taxa proposed by Lynge, two (*P. hieronymi* and *P. prolixa* var. *rosea*) were destroyed at Berlin, and one (*P. coccinea*) was transferred by Lynge himself to *Pyxine coccifera* (Fée) Nyl. Lynge also made two new combinations, *P. brasiliana* var. *glaziovii* (Müll. Arg.) Lynge and var. *novella* (Vain.) Lynge. Two infraspecific taxa (*P. abstrusa* f. *laevigata* Lynge and *P. cornuta* var. *crocea* Lynge) have been raised to species rank by Gyelnik, and a later homonym (*P. merrillii* Lynge non Vain.) has received a new name. I have reduced 24 species, varieties, or forms to synonymy in the above list of species. A summary of these changes follows:

P. abstrusa f. *laevigata* Lynge = *P. subabstrusa* Gyel.
P. annae Lynge = *P. recipienda* Nyl.
P. ceracea Lynge = *P. recipienda* Nyl.
P. coccinea Lynge = *Pyxine coccifera* (Fée) Nyl.
P. cornuta var. *crocea* Lynge = *P. crocea* (Lynge) Gyel. non Sprengl.
P. fragilis Lynge = *P. intercalanda* Vain.
P. latissima f. *microspora* Lynge = *P. wainii* A. L. Smith
P. longiconida Lynge = *P. scrobicularis* Krempth.
P. malmei Lynge = *P. minima* Lynge, probably
P. melanothrix f. *microspora* Lynge (invalid name) = *P. subproboscidea* Lynge
P. merrillii Lynge, non Vain. = *P. lyngeana* Zahlbr.
P. osseo-albida Lynge (invalid name) = *P. zahlbruckneri* Lynge
P. palmarum Lynge (invalid name) = *P. palmarum ex* Hale
P. paraguariensis Lynge = *P. africana* Müll. Arg.
P. portoalegrensis Lynge = *P. congensis* Stein. provisionally
P. radians Lynge (invalid name) = *P. delicatula* Vain.
P. riograndensis Lynge = *P. bolliana* Müll. Arg., probably
P. rissoensis Lynge = *P. africana* Müll. Arg.
P. saccatiloba f. *membranacea* Lynge (invalid name) = *P. mesotropa* Müll. Arg.
P. silvatica var. *pinnata* Lynge = *P. silvatica* var. *silvatica*
P. silvatica var. *radiata* Lynge = *P. silvatica* var. *silvatica*
P. subregressa Lynge = *P. mesotropa* Müll. Arg.
P. subrugata Krempth. var. *arcuata* Lynge = *P. subrugata* var. *subrugata*
P. wainioana Lynge = *P. caroliniana* Nyl.

Misidentifications and changes in nomenclature include the following 20 taxa:

P. abstrusa f. *laevigata* Lynge pr. p. = *P.* cf. *relicina* Fr.
P. balansae var. *sorediata* Müll. Agr. = *P. subbalansae* Gyel.
P. conspersa (Ach.) Ach. = *P. isidiata* (Anzi) Gyel. + *P. flavida* Zahlbr.
P. cyliphora (Ach.) Vain. = *P. caperata* (L.) Ach.
P. flava Kremplh. var. *stellata* Lynge = *P. flavida* Zahlbr var. *stellata* (Lynge) Zahlbr.
P. flava var. *subdichotoma* Lynge = *P. flavida* Zahlbr. var. *subdichotoma* (Lynge) Zahlbr.
P. gracilis (Müll. Arg.) Vain. = *P. zahlbruckneri* Lynge
P. isidiophora Zahlbr. = *P. caroliniana* Nyl.
P. kamtschadalis var. *americana* (Mey. & Flot.) Nyl. = *P. americana* (Mey. Flot.) Mont.
P. laceratula Nyl. = *Parmelia* sp. near *P. riograndensis* Lynge and *P. squamuligera* Sant.
P. latissima Fée pr. p. = *P. zollingeri* Hepp
P. magna Lynge pr. p. = *P. microdactyla* Hale
P. melanothrix (Mont.) Vain. pr. p. = *P. argentina* Kremplh.
P. pachyderma Hue = *P. fistulata* Tayl.
P. perforata (Jacq.) Ach. = *P. leucosemotheta* Hue + *P. subcaperata* Kremplh.
P. persulphurata Nyl. = *P. cornuta* Lynge, probably.
P. proboscidea Tayl. = *P. wainii* A. L. Smith
P. saccatiloba Tayl. = *P. mesotropa* Müll. Arg.
P. uleana Müll. Arg. = *P. sphaerospora* Nyl.
P. urceolata Eschw. = *P. eciliata* (Nyl.) Nyl.

Four other species, *P. consimilis* Vain., *P. cristfera* Tayl., *P. minarum* Vain., and *P. revoluta* Floerke, were also misidentified, but it was impossible to correct the names because of the poor condition of the specimens.

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By WILLIAM RANDOLPH TAYLOR

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MARINE ALGAE FROM THE TROPICAL ATLANTIC OCEAN: V. ALGAE FROM THE LESSER ANTILLES

WILLIAM RANDOLPH TAYLOR

Introduction

In preparing a general account of the marine algae of the West Indies and neighboring coasts the writer has had many occasions to note apparent discontinuities of range, or ranges of conspicuous algae much less extensive that it seems reasonable to expect. One who knows the West Indian algal flora well discounts these deceptive ranges, but is nevertheless restricted in the range he can cite for species. The algae of very few places in the West Indies or nearby have been thoroughly studied; even those places that have been visited and the algae superficially studied are widely scattered.

The marine algae of the Virgin Islands (while still the Danish West Indies) were thoroughly studied and described by Børgesen (1913–20), and his papers are the most informative of any dealing with West Indian algae. Famous among the algal works on the Lesser Antilles are the books based on the collections of A. Schramm and H. Mazé in Guadeloupe (Schramm and Mazé 1865, 1866; Mazé and Schramm 1870–77), the identifications having been made by the brothers Crouan, well-known phycologists of Brest. These are rare books in the original issues. The collections were made with great discernment, but the identifications took little account of the great variability of many of these plants, and the publications while proposing scores of new species seldom provided descriptions of the plants. It appears that no definitive set of specimens was set aside; several institutions possess considerable series of them but the specimens under a given collection number are not always identical as to species. Hamel and Hamel-Joukov supplemented these works later (1929, 1931), as did Questel (1951).

Grieve gave a brief list of Dominican algae (1909). The algae of Martinique have often been collected but reported only in scattered notes. A study of the algae of Barbados (Vickers 1905, 1908) yielded a rather limited list and a handsome atlas of selected Chlorophyceae and Phaeophyceae. The writer has reported on small collections from the Lesser Antilles in a few papers (1929, 1940, 1942). Lists

from several sources appear in the reports of the famous H.M.S. "Challenger" expedition, but they are in part simply recapitulations of earlier-published accounts.

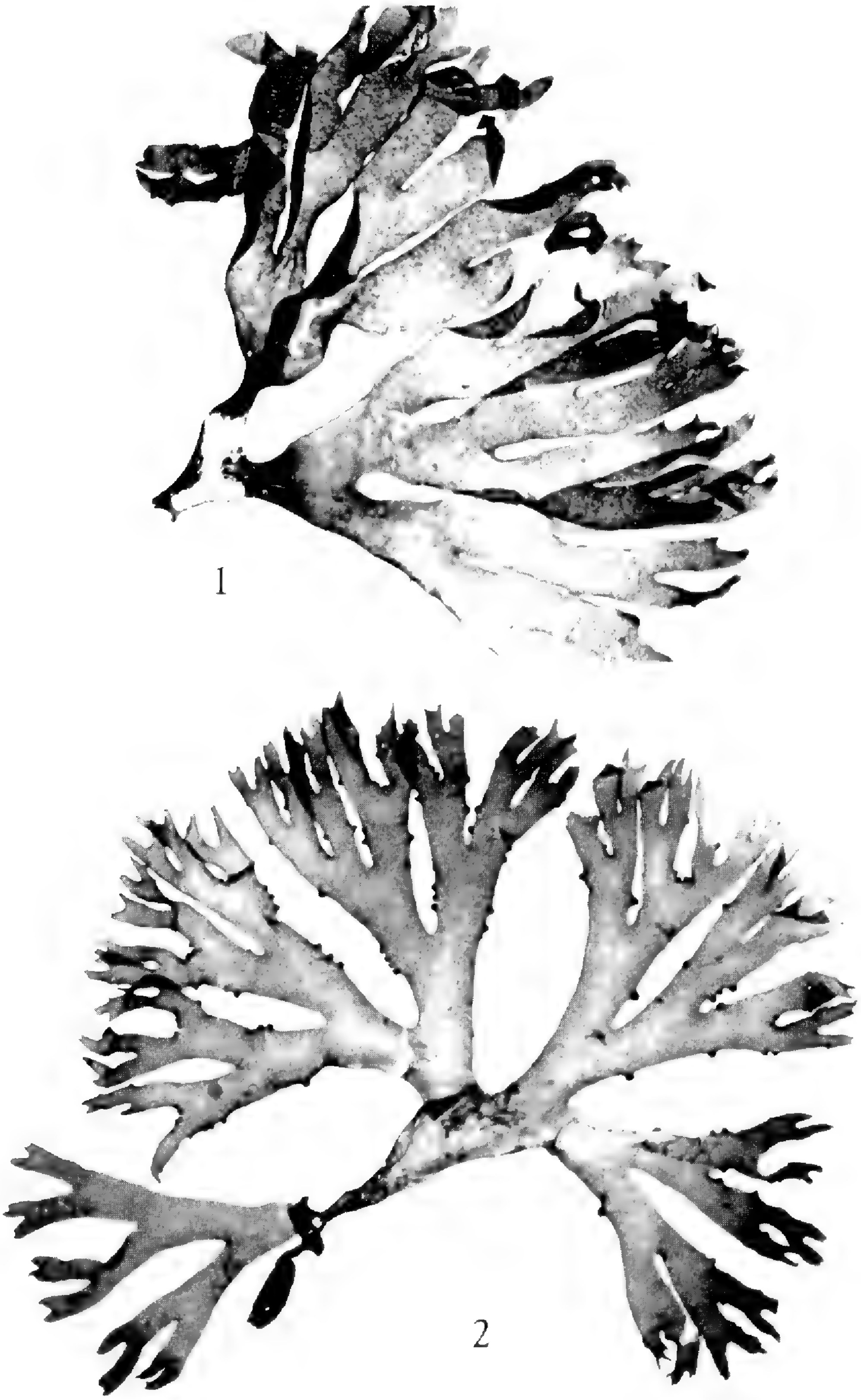
The only comprehensive catalog of West Indian (including Lesser Antilles) algae is that of Murray (1888, 1889) which brings together all reports up to that date in one list, but unfortunately it is quite uncritical, including records almost without question or verification, in particular those of Schramm and Mazé without remark, even when their names are *nomina nuda*. The writer in his recent (1960) general work has attempted to select the most reliable reports from the Lesser Antilles as well as other West Indian and mainland countries and to segregate those which are doubtful.

It is very satisfying to be able to report now on useful collections from the British Virgin Islands, Barbuda, Nevis, and Antigua, and even more substantial ones from St. Kitts, St. Lucia, and Grenada, which in the very great majority of cases provide the first records of these plants from those islands, and in several cases extend the known ranges of the plants along the chain. These collections did not come to hand in time to be studied and the records entirely incorporated in the general account mentioned above (Taylor 1960), though it was possible to introduce a very considerable number of the Grenada records and a few others of special interest. No general conclusions can be derived from these collections—they fill in gaps in our knowledge but do not change our general picture of the West Indian algal flora.

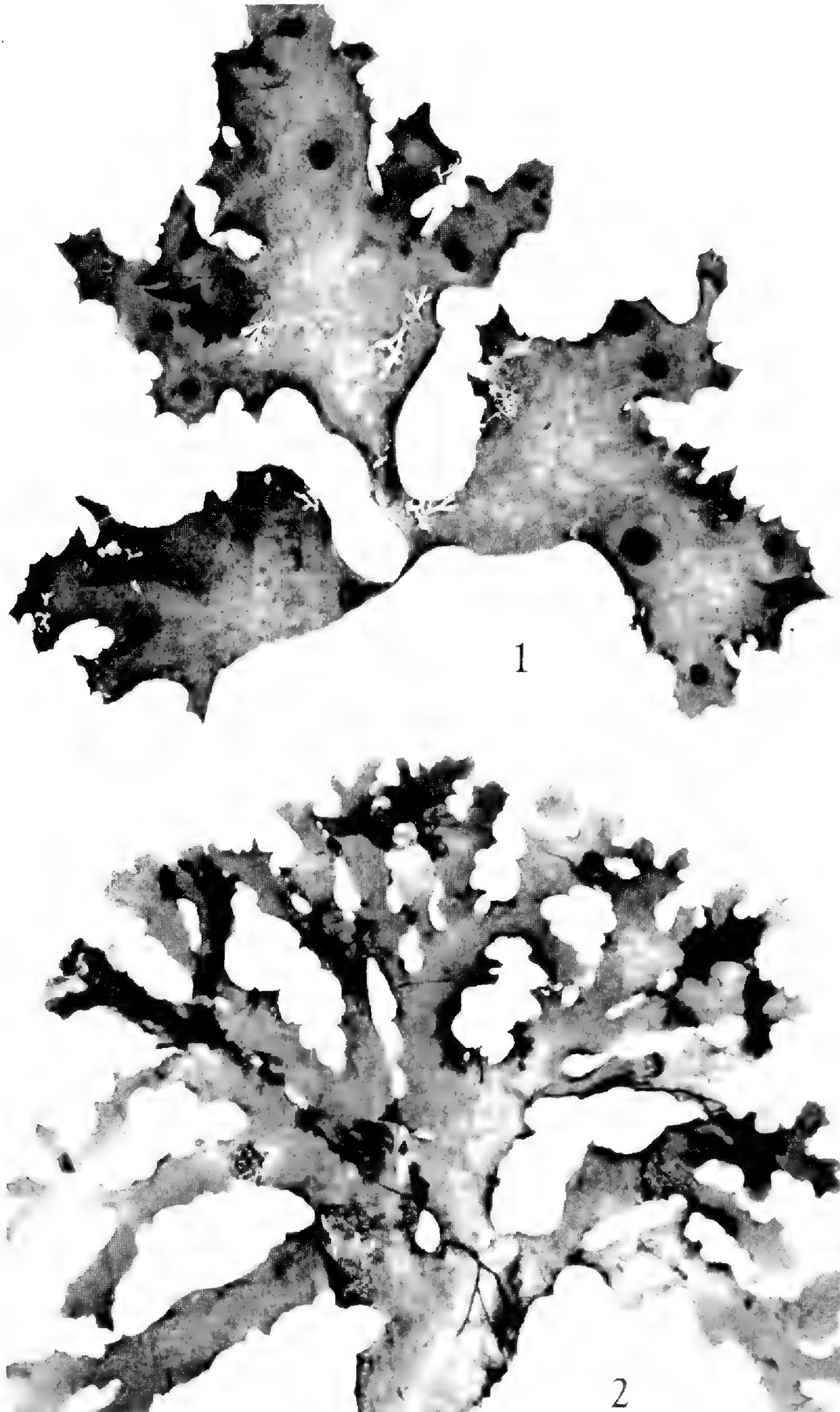
The material from the Smithsonian-Bredin Caribbean Expeditions of 1958 and 1959 was submitted through the kindness of Dr. Fenner A. Chace, Jr., Curator of Marine Invertebrates, U.S. National Museum, and Dr. Waldo L. Schmitt, Emeritus Head-Curator of Zoology and one of the collectors on the expeditions. That from the Institute of Jamaica-Arnold Arboretum (Harvard University) Expedition was submitted by C. Bernard Lewis, Director of the Institute, on behalf of the collector, Mr. George R. Proctor and of Mrs. Lena Green, the curatorial assistant who prepared the material for study. To all of these the writer is exceedingly grateful for the opportunity of studying the specimens. The first set of the Smithsonian-Bredin collection is in the U.S. National Museum, and that of the plants collected by Mr. Proctor in the Science Museum of the Institute of Jamaica.

Localities

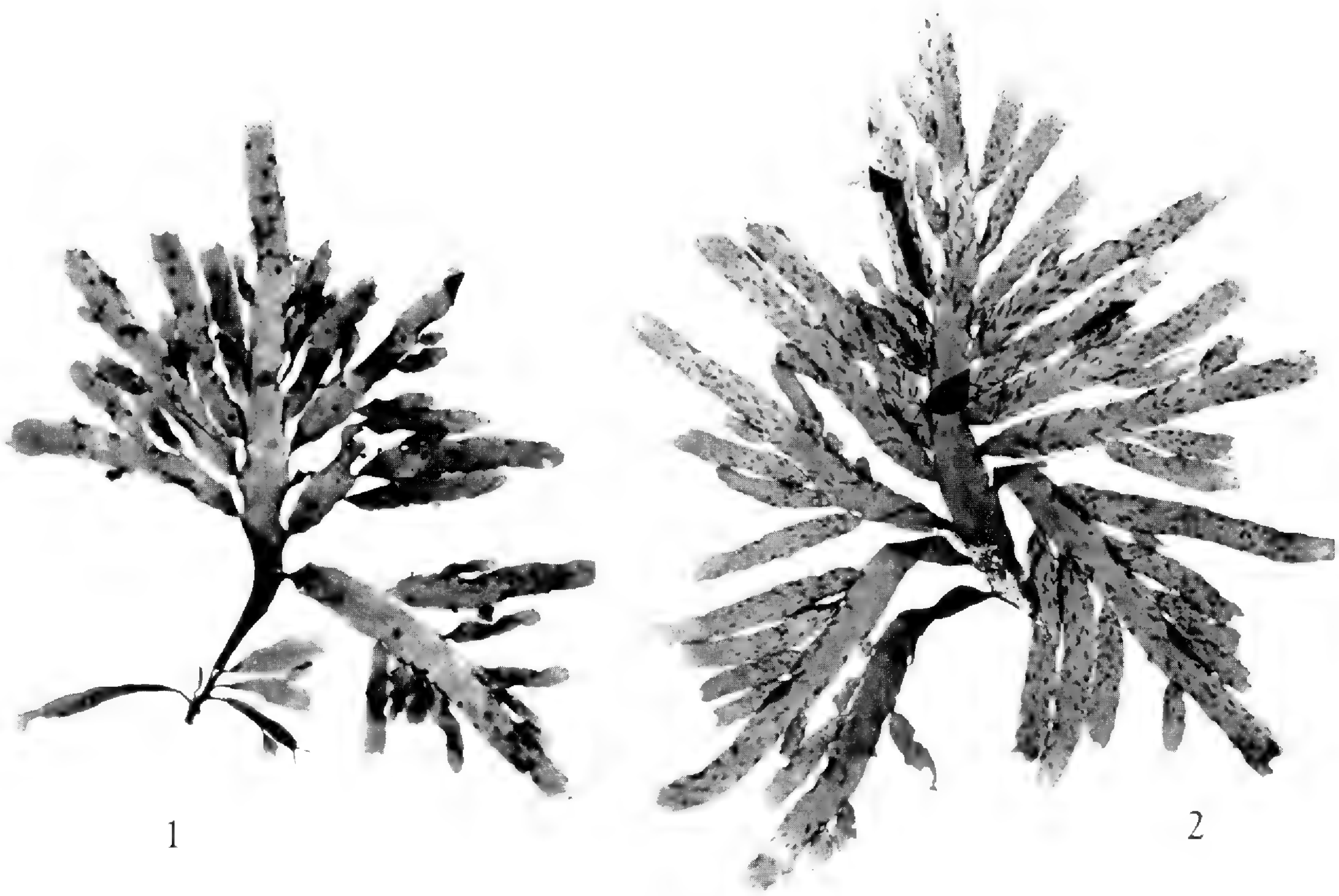
As a large number of species are involved and as it is impossible in any case to designate the precise environment of individual specimens, since they were grouped together in large jars, a general characterization of each major station will be given below. The individual



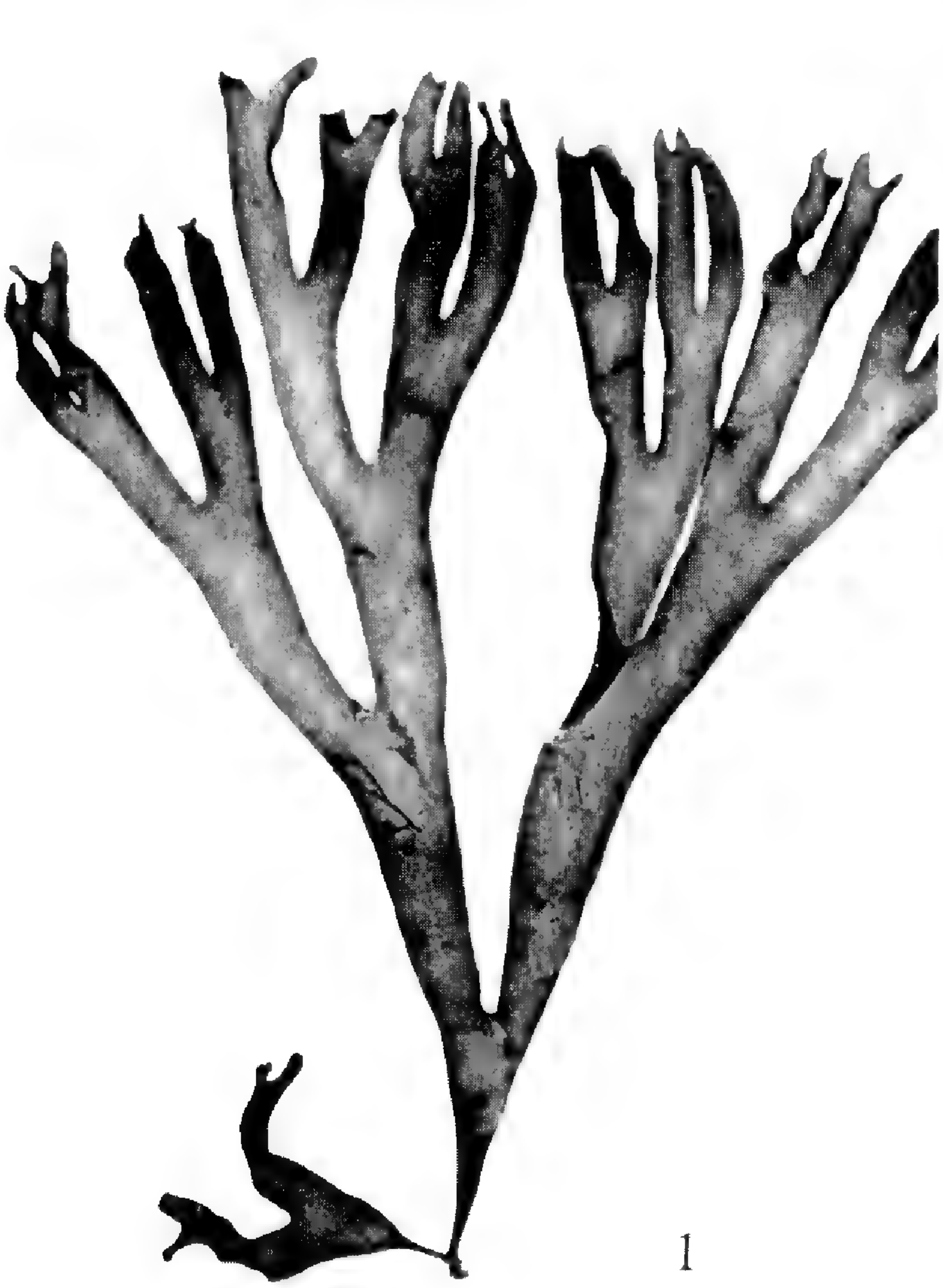
FIGURES 1–2. *Sarcodiotheca caribaea:* 1, spermatangial plant, ×1.35; 2, type, cystocarpic plant, ×1.35.



FIGURES 1–2. *Meristotheca tobagensis:* 1, cystocarpic plant, ×1.7; 2, type, spermatangial plant, ×1.9.



FIGURES 1–2. *Waldoia antillana:* 1, cystocarpic plant, ×1.1; 2, type, tetrasporic plant, × 1.1



1

2

FIGURES 1–2.—1, *Sarcodiotheca caribaea*, tetrasporic plant, ×1.3. 2. *Waldoia antillana*, detail of part of a tetrasporic plant showing stichidia, ×2.3.

numbers for the Smithsonian specimens were supplied by the writer when mounting the plants for study; those with the Proctor specimens were assigned by the Science Museum.

Smithsonian-Bredin Caribbean Expedition of 1958

The algae of the Smithsonian-Bredin Expeditions were collected incidental to other tasks by various persons, particularly by Dr. Waldo L. Schmitt, to whose continuing interest in all living things of the shore, and generosity in contributing the plants for study, the writer has been deeply indebted for many years. Dr. Schmitt collected at most of the localities; Dr. Richard S. Cowan collected at Pigeon Island, St. Lucia, at some of the Barbuda localities, and Man-of-War Bay, Tobago, and Dr. Paul Denckla collected the algae at Antigua.

Station 9–58. British Virgin Islands, B.W.I., Guano Island, White Bay. Reefs in a cove, from honeycombed rocks and Porites clumps, just off shore and at a depth of about 2 meters, Mar. 28, 1958. Collector: W. L. Schmitt.

Stations 18 & 21–58. British Virgin Islands, B.W.I., Peter Island, Little Bay. Dredged from 4.5–15.0 meters, Mar. 29, 30, 1958. Collector: W. L. Schmitt.

Station 42–58. British Virgin Islands, B.W.I., Anegada Island, Pomato Point. Collected over the edge of a reef and on eel-grass flats at depths to one meter, Apr. 8, 1958. Collector: W. L. Schmitt.

Station 67–58. Nevis, B.W.I., Charlestown. Dredged about the anchorage over a weedy bottom at 3.6–5.5 meters, Apr. 16, 1958. Collector: W. L. Schmitt.

Station 113a–58. Barbuda, B.W.I., Gravenor Landing. Collected along shore in honeycombed coral rock and limestone, and in turtle grass beds, Apr. 28, 1958. Collector: W. L. Schmitt.

Smithsonian-Bredin Caribbean Expedition of 1959

Tobago, B.W.I., Man-of-War Bay, Apr. 7, 1959. Collector: R. S. Cowan.

St. Lucia, B.W.I., Marigot Bay, Apr. 14, 1959. Collectors: W. L. Schmitt et al.

St. Lucia, B.W.I., Pigeon Island, Apr. 16, 1959. Collector: R. S. Cowan.

Barbuda, B.W.I., Barbuda lagoon, Apr. 25, 1959. Collector: R. S. Cowan.

Barbuda, B.W.I., Cocoa Point, Apr. 26, 1959. Collector: R. S. Cowan.

Station 119–59. Antigua, B.W.I., Reeds Beach, a private beach in the Mill Reef Club area north of English Harbor, May 4, 1959. Collector: Paul Denckla.

INSTITUTE OF JAMAICA-ARNOLD ARBORETUM EXPEDITIONS OF 1958, 1959

Collector for all stations, George L. Proctor. No station numbers were supplied.

St. Kitts, B.W.I., Black Rocks. Tidepools in rough lava rock, subject to violent wave action, Mar. 14, 1959.

St. Kitts, B.W.I., Conaree Beach. Attached to rocks lightly covered by shifting sand at depths of 1.5–3.0 dm., Mar. 28, 1959.

St. Kitts, B.W.I., Frigate Bay. Attached to boulders at depths of 1.5–3.0 dm., Mar. 29, 1959.

St. Kitts, B.W.I., North Friars Bay. On ledges and in tidepools washed by violent surf, Mar. 29, 1959.

St. Kitts, B.W.I., South Friars Bay. On partly submerged rocks accompanied by some sand, Mar. 29, 1959.

Nevis, B.W.I., near Red Cliff. Collected along a rocky shore at depths of 1.5–3.0 dm., Mar. 20, 1959.

St. Lucia, B.W.I., Marquis Bay. Collected along rocky shores, May 16, 1958.

St. Lucia, B.W.I., Vigie Point. From rocky ledges in heavy surf, June 1, 1958.

LIST OF SPECIES

Myxophyceae

Oscillatoriaceae

Lyngbya majuscula Harv. ex Gom. Ann. Sci. Nat., Bot. VII, 16: 131. 1892.

ANTIGUA: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59a. A very widely distributed species.[1]

Chlorophyceae

Ulvaceae

Enteromorpha flexuosa (Wulf.) J. Ag. Lunds Univ. Årsskr., Afd. Math. Naturvetensk. 19(2): 126. 1883.

GRENADA: True Blue, coll. Proctor no. A–2699. Range from Bermuda and North Carolina to Uruguay.

Ulva fasciata Delile. Flore d'Égypte 153. 1813.

NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58a. Range from Bermuda and North Carolina to Uruguay.

Cladophoraceae

Chaetomorpha brachygona Harv. Smiths. Contr. Knowl. 10: 87. 1858.

NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58e. Range from Bermuda and North Carolina to Brazil.

Chaetomorpha crassa (C. Ag.) Kütz. Phycol. Germ. 204. 1845.

ST. KITTS: Frigate Bay, coll. Proctor no. A–3166. The easternmost record to date. Range hitherto Bermuda, Virgin Islands, and St. Barthélemy.

[1] The range as given applies only to the distribution of these plants in the warmer latitudes of the western Atlantic Ocean. Some of them occur in other seas as well.

Chaetomorpha media (C. Ag.) Kütz. Spec. Alg. 380. 1849.

British Virgin Islands: Guano Island, coll. Schmitt, Smiths.-Bredin no. 2. St. Kitts: Black Rocks, coll. Proctor no. A–3206; Conaree Beach, coll. Proctor no. A–3136. St. Lucia: Marquis Bay, coll. Proctor no. A–2782; Vigie Point, Proctor no. A–2790. Range from Bermuda to Brazil.

Cladophora fascicularis (Mert.) Kütz. Linnaea 17: 91. 1843.

Barbuda: Cocoa Point, coll. Smiths.-Bredin no. 84. St. Kitts: Black Rocks, coll. Proctor no. A–3198; S. Friars Bay, coll. Proctor no. A–3173. St. Lucia: Marquis Bay, Proctor no. A–2775. Range from Bermuda and North Carolina to Uruguay.

Cladophora fuliginosa Kütz. Spec. Alg. 415. 1849.

St. Kitts: Conaree Beach, coll. Proctor no. A–3121. The easternmost record to date. Range hitherto from Bermuda to the southern Netherlands Antilles.

Dasycladaceae

Batophora oerstedii J. Agardh, Öfvers. K. Vetensk.-Akad. Förhandl., 11: 108. 1854.

Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 75. Range from Bermuda to British Honduras.

Acetabularia crenulata Lamour. Hist. Polyp. Corall. Flex. 249. 1816.

Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 70. Range from Bermuda to Venezuela.

Valoniaceae

Halicystis osterhoutii L. R. & A. H. Blinks, Bull. Torrey Bot. Club, 57: 389. 1930.

Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59m. Range from Bermuda to the Grenadines, but at few stations.

Valonia macrophysa Kütz. Phycol. Gen. 307. 1863.

British Virgin Islands: Anegada Island, Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58b. A slight northeastward range extension. Range hitherto from Bermuda to the American Virgin Islands.

Valonia ventricosa J. Ag. Lunds Univ. Årsskr., Afd. Math. Naturvetensk., 23(2). 96. 1887.

British Virgin Islands: Anegada Island, Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58a. Range from Bermuda to Brazil.

Dictyosphaeria cavernosa (Forssk.) Børg. Dansk Bot. Ark. 8(2): 2. 1932.

British Virgin Islands: Anegada Island, Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58c. St. Kitts: Black Rocks, coll. Proctor no. A–3190; Conaree Beach, coll. Proctor no. A–3137. Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59g. Range from Bermuda to Brazil.

Cladophoropsis membranacea (C. Ag.) Børg. Overs. K. Danske Vidensk. Selsk: Forhandl. 1905(3): 288. 1905.

St. Kitts: Black Rocks, coll. Proctor no. A–3199. Antigua: Reeds Beach. coll. Denckla, Smiths.-Bredin no. 119–59f. St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 48. Grenada: Grenada Bay, coll. Proctor no. A–2741. Range from Bermuda to Brazil.

Anadyomene stellata (Wulf.) C. Ag. Spec. Alg. Rite Cogn. 1: 400. 1822.

Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 74. Range from Bermuda to Brazil.

Bryopsidaceae

Bryopsis pennata Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 333. 1809.
ST. KITTS: Black Rocks, coll. Proctor no. A–3191. Range from Bermuda to Brazil.

Caulerpaceae

Caulerpa cupressoides (West) C. Ag. Spec. Alg. Rite Cogn. 1: 441. 1822.
NEVIS: Red Cliff (v. *lycopodium* (J. Ag.) Weber-van Bosse f. *alternifolia* Weber-van Bosse), coll. Proctor no. A–3209; (v. *lycopodium* f. *disticha* (Weber-van Bosse) Collins), coll. Proctor no. A–3220; (v. *lycopodium* toward f. *elegans* (Crouan) Weber-van Bosse), coll. Proctor no. A–3223. ST. LUCIA: Marigot Bay (v. *cupressoides*), coll. Schmitt, Smiths.-Bredin no. 42: Pigeon Island (v. *lycopodium*), coll. Cowan, Smiths.-Bredin no. 51. Range from Bermuda to Brazil.

Caulerpa microphysa (Weber-van Bosse) J. Feldm. Rev. Gen. Bot. 62: 424. 1955.
ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 46. Range from Bermuda to Venezuela.

Caulerpa prolifera (Forssk.) Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 332. 1809.
GRENADA: Grenada Bay, Proctor A–2718. Range from Bermuda and Florida to Brazil.

Caulerpa racemosa (Forssk.) J. Ag. Lunds Univ. Årsskr., Afd. Math. Naturvetensk. 9(8): 35. 1873.
BRITISH VIRGIN ISLANDS: Guano Island, coll. Schmitt, Smiths.-Bredin no. 1. BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 85. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2778; Pigeon Island, coll. Cowan, Smiths.-Bredin no. 52; Vigie Point, coll. Proctor no. A–2796. Range from Bermuda and Florida to Brazil.

Caulerpa sertularioides (Gmel.) Howe, Bull. Torrey Bot. Club 32: 576. 1905.
BARBUDA: Cocoa Point, partly approaching v. *farlowii* (Weber-van Bosse) Børg., coll. Cowan, Smiths.-Bredin no. 86. ST. KITTS: Conaree Beach (partly f. *brevipes* (J. Ag.) Sved.), coll. Proctor no. A–3140; South Friars Bay, coll. Proctor no. A–3176. NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58d. ST. LUCIA: Pigeon Island (f. *brevipes* (J. Ag.) Sved.), coll. Cowan, Smiths.-Bredin no. 47; Vigie Point, coll. Proctor A–2792. Range from Bermuda and Florida to Brazil.

Caulerpa verticillata J. Ag. Öfvers. K. Vetensk.-Akad. Förhandl. 4: 6. 1847.
GRENADA: True Blue, coll. Proctor A–2701. Range from Bermuda and Florida to Brazil.

Codiaceae

Avrainvillea nigricans Dec. Ann. Sci. Nat., Bot., II, 18: 108. 1842.
ST. LUCIA: Vigie Point, coll. Proctor no. A–2813 (in part). Range from Bermuda and Florida to Brazil.

Avrainvillea rawsonii (Dickie) Howe, Bull. Torrey Bot. Club 34: 510. 1907.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3115. ST. LUCIA: Vigie Point, coll. Proctor no. A–2806. Range from Bermuda to Barbados.

Udotea flabellum (Ell. & Sol.) Lamour. Nouv. Bull. Sci. Soc. Philom. 3: 180. 1812.
BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 83; Barbuda Lagoon coll. Cowan, Smiths.-Bredin no. 72. ANTIGUA: Reeds Beach, coll. Denckla,

Smiths.-Bredin no. 119–59e. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 49. Range from Bermuda and Florida to Brazil.

Penicillus capitatus Lamarck, Ann. Mus. Hist. Nat. 20: 299. 1813.

BARBUDA: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 73. NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58c. ANTIGUA: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59i. ST. LUCIA: Vigie Point, coll. Proctor no. A–2809; Pigeon Island, coll. Cowan, Smiths.-Bredin no. 50. Range from Bermuda and Florida to Las Aves Island, and at Trinidade Island, off Brazil.

Penicillus dumetosus (Lamour.) Blainv. Man. Actin. Zoophyt. 553. 1834.

ST. KITTS: Conaree Beach, coll. Proctor no. A–3124. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 45. GRENADA: Grenada Bay, coll. Proctor no. A–2714. Range from Bermuda and Florida to Colombia.

Halimeda discoidea Dec. Ann. Sci. Nat., Bot. 18: 102. 1842.

ST. LUCIA: Vigie Point, coll. Proctor A–2805; Pigeon Island, coll. Cowan, Smiths.-Bredin no. 44. A slight eastward extension of range in the West Indies. Range from Florida to Brazil.

Halimeda incrassata (Ellis) Lamour. Hist. Polyp. Corall. Flex. 307. 1816.

BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 87; Barbuda Lagoon coll. Cowan, Smiths.-Bredin no. 71. NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58b. ST. LUCIA: Marigot Bay, coll. Schmitt, Smiths.-Bredin no. 43. Range from Bermuda and Florida to Grenada and the Netherlands Antilles.

Halimeda opuntia (L.) Lamour. Hist. Polyp. Corall. Flex. 308. 1816.

BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 82. ST. KITTS: Conaree Beach, coll. Proctor no. A–3144. NEVIS: Red Cliff, coll. Proctor no. A–3221. GRENADA: True Blue, coll. Proctor no. A–2703. Range from Florida to Brazil.

Codium intertextum Coll. & Herv. Proc. Amer. Acad. Arts Sci. 53: 54. 1917.

ST. BARTHÉLEMY: Anse de Cul-de-Sac, coll. Le Gallo no. 62, Sept. 15, 1955. ST. KITTS: Conaree Beach, coll. Proctor no. A–3141. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 66. Range from Bermuda and Florida to Brazil.

Codium isthmocladum Vickers, Ann. Sci. Nat., Bot., IX, 1: 57. 1905.

ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 65. Range from Bermuda and North Carolina to Brazil.

Xanthophyceae

Vaucheriaceae

Vaucheria dichotoma (L.) C. Ag. Synop. Alg. Scand. 47. 1817.

GRENADA: True Blue, coll. Proctor no. A–2090. Range from Bermuda to Grenada, but reported from only a few stations.

Phaeophyceae

Ectocarpaceae

Ectocarpus breviarticulatus J. Ag. Öfvers. K. Vetensk.-Akad. Förhandl. 4(1): 7. 1847.

ST. KITTS: Conaree Beach, coll. Proctor no. A–3131. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2785; Vigie Point, coll. Proctor no. A–2822. GRENADA: Grenada Bay, coll. Proctor no. A–2729. Range from Jamaica to Brazil.

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Giffordia mitchellae (Harv.) Hamel, Bot. Notiser, 1939: 66. 1939.

ST. LUCIA: Vigie Point, coll. Proctor no. A–2820. The easternmost record of this species in the West Indies to date. Ranging from Bermuda and North Carolina to Guadeloupe, and reported from Brazil.

Dictyotaceae

Dilophus guineensis (Kütz.) J. Ag. Lunds Univ. Årsskr., Afd. Math. Naturvetensk. 17(4): 106. 1882.

ST. KITTS: Conaree Beach, coll. Proctor nos. A–3127, A–3129; North Friars Bay, coll. Proctor no. A–3186. NEVIS: Near Red Cliff, coll. Proctor nos. A–3212, A–3214. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 54; Vigie Point, coll. Proctor no. A–2816. Range from Bermuda and Florida to Venezuela.

Dictyota bartayresii Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 331. 1809.

ANTIGUA: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59c. Range from Bermuda and Florida to Brazil.

Dictyota cervicornis Kütz. Tab. Phycol. 9: 11. 1859.

ANTIGUA: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59d. Range from Bermuda and North Carolina to Brazil.

Dictyota ciliolata Kütz. Tab. Phycol. 9: 12. 1859.

ST. KITTS: Conaree Beach, coll. Proctor nos. A–3122, A–3123, A–3125. Range from Bermuda and Florida to Brazil.

Dictyota dentata Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 331. 1809.

ST. KITTS: Conaree Beach, coll. Proctor A–3133. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 57. GRENADA: Grenada Bay, coll. Proctor no. A–2716. Range from Bermuda and Florida to Brazil.

Dictyota dichotoma (Huds.) Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 331. 1809.

NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58h. Range from Bermuda and North Carolina to Brazil.

Dictyota jamaicensis Taylor, Mar. Alg. East. Trop. Subtrop. Coasts Amer. 630. 1960.

ST. KITTS: Frigate Bay, coll. Proctor no. A–3164. ST. LUCIA: Vigie Point, coll. Proctor no. A–2798. Hitherto known from Jamaica, Grenada, and Venezuela.

Dictyopteris delicatula Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 332. 1809.

ST. KITTS: Conaree Beach, coll. Proctor no. A–3130 (in part). ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin nos. 44 (mixed with *Halimeda discoidea*), 55 (in part). Range from Bermuda and Florida to Brazil.

Dictyopteris jamaicensis Taylor, Mar. Alg. East. Trop. Subtrop. Coasts Amer. 631. 1960.

GRENADA: Grenada Bay, coll. Proctor no. A–2739. Previously only known from Jamaica.

Dictyopteris justii Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 332. 1809.

ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 56. Range from Bermuda and Florida to Brazil.

Pocockiella variegata (Lamour.) Papenf. Amer. Journ. Bot. 30: 467. 1943.

NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58g. ST. LUCIA, Pigeon Island, coll. Cowan. Smiths.-Bredin no. 53. Range from Bermuda and North Carolina to Brazil.

Stypopodium zonale (Lamour.) Papenf. Bot. Notiser, 1940: 205. 1940.
St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 64. Range from Bermuda and Florida to Brazil.

Padina gymnospora (Kütz.) Vickers, Ann. Sci. Nat., Bot., IX, 1: 58. 1905.
St. Kitts: Conaree Beach, coll. Proctor no. A–3147. Nevis: Near Red Cliff, coll. Proctor no. A–3216. St. Lucia: Vigie Point, coll. Proctor no. A–2812. Grenada: Grenada Bay, coll. Proctor no. A–2711. Range from Bermuda and Florida to Brazil.

Padina sanctae-crucis Børg. Dansk Bot. Ark. 2(2): 45. 1914.
Grenada: Grenada Bay, coll. Proctor no. A–2712. Range from Bermuda and Florida to Brazil.

Padina vickersiae Hoyt in Britt. & Millsp. Bahama Flora 595. 1920.
St. Kitts: Frigate Bay, coll. Proctor no. A–3156. Grenada: True Blue, coll. Proctor no. A–2696. Range from Bermuda and North Carolina to Brazil.

Punctariaceae

Colpomenia sinuosa (Roth) Derb. & Sol. Comptes Rend. Séanc. Acad. Sci. Suppl. 1: 11. 1856.
Nevis: Red Cliff, coll. Proctor no. A–3225. Range from Bermuda and North Carolina to Brazil.

Chnoospora minima (Hering) Papenf. Journ. So. Afr. Bot. 22(2): 69. 1956.
St. Lucia: Vigie Point, coll. Proctor no. A–2781. Tobago: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 27. Range from Redonda Island to Brazil.

Sargassaceae

Sargassum fluitans Børg. Dansk Bot. Ark. 2(2): 66. 1914.
Nevis: Red Cliff, coll. Proctor no. A–3126. Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59j. Range from Bermuda and Florida to Panama.

Sargassum natans (L.) J. Meyen, Arch. für Naturgesch. [Wiegm.], 4(2): 185. 1838.
Barbuda: Cocoa Point, coll. Cowan, Smiths.-Bredin nos. 88, 93. Nevis: Red Cliff, coll. Proctor no. A–3125. Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59k. Range from Bermuda and North Carolina to British Honduras.

Sargassum platycarpum Mont. Ann. Sci. Nat., Bot. II, 18: 248. 1842.
St. Kitts: Conaree Beach, coll. Proctor no. A–3151. Range from Bermuda to Brazil.

Sargassum polyceratium Mont. Ann. Sci. Nat., Bot., II, 8: 356. 1837.
St. Kitts: Conaree Beach, coll. Proctor no. A–3149. Range from Bermuda and Florida to Brazil.

Sargassum rigidulum Kütz. Spec. Alg. 615. 1849.
St. Kitts: Black Rocks, coll. Proctor no. A–3200. Range from Bermuda to Brazil.

Sargassum vulgare C. Ag. Spec. Alg. Rite Cogn. 1: 3. 1820.
St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 59; Vigie Point, coll. Proctor no. A–2797. Grenada: Grenada Bay, coll. Proctor no. A–2735. Var. *foliosissium* (Lamour.) J. Ag.: British Virgin Islands: Guano Island, coll. Schmitt, Smiths.-Bredin no. 3. Range from Bermuda and Florida to Brazil.

Turbinaria tricostata Barton, Trans. Linn. Soc., Bot. II, 3: 218. 1891.
BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 94. Range from Bermuda to the Netherlands Antilles.

Turbinaria turbinata (L.) Kuntze, Rev. Gen. Plant. 3: 434. 1898.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3142. Range from Florida to Brazil.

Rhodophyceae

Helminthocladiaceae

Liagora ceranoides Lamour. Hist. Polyp. Corall. Flex. 239. 1816.
ST. KITTS: North Friars Bay, coll. Proctor no. A–3185. Range from Bermuda and Florida to Brazil.

Liagora farinosa Lamour. Hist. Polyp. Corall. Flex. 240. 1816.
ST. KITTS: Frigate Bay, coll. Proctor no. A–3159. Range from Bermuda and Florida to Brazil.

Liagora valida Harv. Smithson. Contr. Knowl. 5(5): 138. 1853.
ST. KITTS: South Friars Bay, coll. Proctor no. A–3195 (young and soft). Range from Bermuda and Florida to Panama.

Chaetangiaceae

Galaxaura cylindrica (Ell. & Sol.) Lamour. Expos. Méthod. Genres Ordre Polypiers 22. 1821.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3139. Range from Bermuda and Florida to Brazil.

Galaxaura oblongata (Ell. & Sol.) Lamour. Hist. Polyp. Corall. Flex. 262. 1816.
ST. LUCIA: Vigie Point, coll. Proctor no. A–2799. Range from Bermuda and Florida to Brazil.

Galaxaura obtusata (Ell. & Sol.) Lamour. Hist. Polyp. Corall. Flex. 262. 1816.
NEVIS: Near Red Cliff, coll. Proctor no. A–3224. Range from Bermuda and Florida to Brazil.

Galaxaura rugosa (Ell. & Sol.) Lamour. Hist. Polyp. Corall. Flex. 263. 1816.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3138; Frigate Bay, coll. Proctor no. A–3161. ST. LUCIA: Vigie Point, coll. Proctor no. A–2795. Range from Bermuda and Florida to Brazil.

Galaxaura squalida Kjellm. K. Svenska Vetensk.-Akad. Handl. 33(1): 55. 1900.
ST. KITTS: Frigate Bay, coll. Proctor no. A–3170. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 61. Range from Bermuda and Florida to Venezuela.

Galaxaura subverticillata Kjellm. K. Svenska Vetensk.-Akad. Handl. 33(1): 48. 1900.
ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 62. Range from Bermuda and Florida to British Honduras.

Gelidiaceae

Gelidiella acerosa (Forssk.) Feldm. & Hamel, Rev. Gén. Bot. 46: 533. 1934.
ST. LUCIA, Pigeon Island, coll. Cowan, Smiths.-Bredin no. 69. ST. LUCIA: Marquis Bay: coll. Proctor no. A–2774; Vigie Point, coll. Proctor no. A–2793. GRENADA: Westerhall Point, coll. Proctor no. A–2683. Range from Bermuda and Florida to Brazil.

Rhizophyllidaceae

Ochtodes secundiramea (Mont.) Howe *in* Britt. & Millsp. Bahama Fl. 583. 1920.

St. Kitts: Black Rocks, coll. Proctor no. A–3189. St. Lucia: Vigie Point, coll. Proctor no. A–2825. Range from the Bahamas to Trinidad.

Corallinaceae

Fosliella farinosa (Lamour.) Howe *in* Britt. & Millsp. Bahama Fl. 587. 1920.

St. Kitts: Conaree Beach, coll. Proctor no. A–3127. Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59p. Range from Bermuda and North Carolina to Brazil.

Fosliella lejolisii (Rosan.) Howe *in* Britt. & Millsp. Bahama Fl. 588. 1920.

Nevis: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58i. Range from Prince Edward Island to Brazil.

Amphiroa fragilissima (L.) Lamour. Hist. Polyp. Corall. Flex. 298. 1816.

Anegada Island: Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58d (lesser part). St. Lucia: Pigeon Island, coll. Smiths.-Bredin no. 68 (lesser part). Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59l. Range from Bermuda and North Carolina to Brazil.

Amphiroa hancockii Taylor, Allan Hancock Atlantic Exped. 2: 95. 1942.

St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 63. Hitherto only known from Hispaniola and Panama.

Amphiroa rigida Lamour. var. **antillana** Børg. Dansk Bot. Ark. 3(1c): 183. 1917.

St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin nos. 67, 68. Range from Florida to Panama.

Corallina officinalis Linn., Fauna Suecica, edit. alt. 539. 1761.

St. Lucia: Marquis Bay, coll. Proctor A–2770. A very interesting find, because, although this plant occurs further south as well as north, reports of it from the West Indies are extremely untrustworthy. The material is quite typical. Range south to North Carolina, and again from Brazil and Uruguay southward, with this as a new intermediate station.

Jania adhaerens Lamour. Hist. Polyp. Corall. Flex. 270. 1816.

Anegada Island: Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58d (lesser part). Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 81 (lesser part). St. Lucia: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 68. The last is probably a new eastern record for the West Indies.

Jania capillacea Harv. Smithson. Contr. Knowl. 5(5): 84. 1853.

St. Kitts: Black Rocks, coll. Proctor no. A–3203. St. Lucia: Vigie Point, coll. Proctor nos. A–2804, A–2810 (in small part). Range from Florida to Brazil.

Jania rubens (L.) Lamour. Nouv. Bull. Sci. Soc. Philom. 3: 186. 1812.

Anegada Island Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58e (in part). Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 79. Grenada: Grenada Bay, coll. Proctor no. A–2730. Range from Bermuda and North Carolina to Uruguay.

Grateloupiaceae

Halymenia floresia (Clem.) C. Ag. Spec. Alg. Rite Cogn. 1: 209. 1822.

St. Lucia: Vigie Point, coll. Proctor no. A–2801. Range from Bermuda and North Carolina to Brazil.

Grateloupia cuneifolia J. Ag. Öfvers. K. Vetensk.-Akad. Förhandl. 6: 85. 1849.
ST. KITTS: Black Rocks, coll. Proctor nos. A–3145, A–3208. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2771. A slight eastward extension of range in the West Indies. Range from Jamaica to Uruguay.

Grateloupia dichotoma J. Ag. Algae Maris Medit. Adriat. 103. 1842.
ST. KITTS: Black Rocks, coll. Proctor no. A–3192. Range from Jamaica to Trinidad.

Grateloupia filicina (Wulf.) C. Ag. Spec. Alg. Rite Cogn. 1: 223. 1822.
BARBUDA: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 92. ST. KITTS: South Friars Bay, coll. Proctor no. A–3172; Frigate Bay, coll. Proctor no. A–3155, A–3157. Range from North Carolina to Brazil.

Cryptonemia luxurians (Mert.) J. Ag. Spec. Gen. Ord. Alg. 2: 228. 1851.
GRENADA: Grenada Bay, coll. Proctor no. A–2721. Range from Bermuda and Florida to Brazil.

Gracilariaceae

Gracilaria curtissiae J. Ag. Lunds Univ. Årsskr. Afd. Math. Naturvetensk. 21(8): 61. 1886.
GRENADA: Grenada Bay, coll. Proctor no. A–2722.

Gracilaria debilis (Forssk.) Børg. Dansk Bot. Ark. 8(2): 7. 1932.
ST. KITTS: Conaree Beach, coll. Proctor nos. A–3116, A–3118a, b, A–3143; North Friars Bay, coll. Proctor no. A–3181. NEVIS: Red Cliff, coll. Proctor no. A–3222. GRENADA: Grenada Bay, coll. Proctor no. A–2237. Range from Bermuda and Florida to Brazil.

Gracilaria domingensis Sonder, *herb.*, *Sphaerococcus domingensis* Kütz. Tab. Phycol. 19: 8. 1869; *G. domingensis* Sonder ex Collins, Proc. Amer. Acad. Arts Sci. 37: 254. 1901.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3132. GRENADA: Grenada Bay, coll. Proctor no. A–2723. Range from Jamaica to Brazil.

Gracilaria ferox J. Ag. Spec. Gen. Ord. Alg. 2(2): 592. 1852.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3150; North Friars Bay, coll. Proctor no. A–3179; Frigate Bay, coll. Proctor no. A–3171. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2786. Range from Bermuda and Florida to Brazil.

Gracilaria foliifera (Forssk.) Børg. Dansk Bot. Ark. 8(2): 7. 1932.
GRENADA: True Blue, coll. Proctor nos. A–2698, A–2707. TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 31. Range from Bermuda and North Carolina to Uruguay.

Gracilaria verrucosa (Huds.) Papenf. Hydrobiol. 2: 195. 1950.
ST. KITTS: Conaree Beach, coll. Proctor no. A–3117. NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58k. TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 28. Range from Bermuda and North Carolina to Brazil.

Solieriaceae

Sarcodiotheca caribaea nov. sp. PLATE 1, FIGURES 1, 2; PLATE 4, FIGURE 1

Plantae omnes infra breviter teretes supra ad laminan 4–8 irregulariter dichotome furcatam, ramis ligulatis 4–10 mm. lat. super furcationes inferiores, 1–2 mm. in divisionibus supremis, marginibus integris, expansae; tetrasporangia super thallam dispersa, 30–38 μ

diam., 45–55 μ longa; cystocarpi prominentes, marginales, intus parenchymatici; pericarpi ostiolati, intus filamentosi, nonnullis filis inter gonimoblastos ad centrum sterile extensis.

Plants arising from very small, lobed, cushion-shaped holdfasts, briefly terete below and often with 1–3 proliferations from the holdfast or the stalk, each expanding above to a 4–8 times irregularly dichotomous blade with a tapering base, the strap-shaped branches 4–10 mm. broad above the lower forkings, 1–2 mm. in the uppermost divisions, the tips rather acute, the margins entire. Blade thickness to 400–500 μ, the cortex of one layer of small cells and the outer medulla of two layers, the inner ones rather large; medullary cavity small, loosely crossed by oblique thicker-walled filaments about 18–25 μ in diameter, and thinner-walled ones about 4.5–14 μ. Tetrasporangia scattered over the thallus, extending inward from the cortex, zonate, 30–38 μ in diameter, 45–55 μ long. Spermatangia widely distributed in patches over the surface. Cystocarps prominent, marginal, with a parenchymatous core, the pericarps ostiolate, filamentous within, with some strands extending between the gonimoblasts to the sterile center; carposporangia produced in short centripetal series.

Type in the U.S. National Herbarium, collected in Man-of-War Bay, Tobago, British West Indies, April 7, 1959, by Richard S. Cowan (No. 41).

These plants agree in most respects with the description of *Sarcodiotheca*, the only particular discrepancy lying in the restriction of the cystocarps to the margin, where they are strongly elevated. Individuals of west-coast species of the genus may, on occasion, have some of them along the margin. Since this is the first record of the genus in the western Atlantic in a family not represented there by many species, it is of particular interest.

Agardhiella tenera (J. Ag.) Schmitz, Flora 72: 441. 1889.

TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 38. Range from North Carolina to Brazil.

Eucheuma isiforme (C. Ag.) J. Ag. Öfvers. K. Vetensk.-Akad. Förhandl. 4: 16. 1847.

BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin no. 95; Gravenor Landing, coll. Cowan, Smiths.-Bredin no. 26. This records a slight eastward extension of range. Range hitherto Bermuda and Florida to St. Barthélemy.

Meristotheca tobagensis nov. sp. PLATE 2, FIGURES 1, 2

Plantae foliosae, in margine irregulariter furcatae; plantae spermatangiales identidem irregulariter ad subdichotome furcatae, in partibus inferioribus ad 1.0 cm. lat., modice ad valde eroso-dentatae; plantae cystocarpicae lobos relative latiores, simpliciores magis irregulares, sursum valde aculeato-dentatae; cystocarpi 0.5–2.5 mm. diam., superficiales aut elevati super superficiem dispersi.

Plants foliose, to at least 6 cm. in height, the fleshy blades reaching a thickness of 530 μ, marginally irregularly forked, but probably sexually dimorphic. Structurally showing an outer cortex of one layer of oval cells about 5 μ in diameter, 15 μ tall, below a firm gelatinous cuticle, and resting on a layer of small rounded ones. Outer medulla of about 3 layers of thick-walled cells, the inner ones being very large, enclosing a filamentous central medulla, this being rather loose in the younger parts, dense near the base. Spermatangial plants several times irregularly to subdichotomously forked, to 1.0 cm. broad in the lower parts, or 1.5 cm. where subcuneate below a fork, the ultimate divisions more band-shaped and tapering, moderately to strongly erose-dentate. Cystocarpic plants with relatively broader, simpler and more irregular lobes rather than forking blades, these very strongly aculeate-dentate above and, scattered over the surface, bearing conspicuous superficial or elevated cystocarps 0.5–2.5 mm. in diameter, each with a thick ostiolate pericarp, this parenchymatous without but with a filamentous lining. Gonimoblasts surrounding a parenchymatous core, this externally interrupted by groups of filaments spreading over the surface and bearing the small carposporangia. Tetrasporangial plants not seen.

Type in the U.S. National Herbarium, collected in Man-of-War Bay, Tobago, British West Indies, April 7, 1959, by Richard S. Cowan (no. 40, spermatangial and cystocarpic plants).

In the absence of tetrasporangial material and with too little cystocarpic material to permit a developmental study, the generic assignment of these plants must be considered tentative. They are far smaller and less broadly foliar than *M. florida* Kylin, an ill-known plant although reported from Florida to Panama, and more regularly branched than the type species, *M. papulosa* (Mont.) J. Ag., which is not known to occur in the West Indies.

Hypneaceae

Hypnea musciformis (Wulf.) Lamour. Mém. Muséum [Paris], 20: 43. 1813.

St. Kitts: Black Rocks, coll. Proctor no. A–3194; Conaree Beach, coll. Proctor no. A–3120; South Friars Bay, coll. Proctor no. A–3174; Frigate Bay, coll. Proctor nos. A–3158, A–3162. St. Lucia: Vigie Point, coll. Proctor no. A–2807. Range from Bermuda and North Carolina to Brazil.

Hypnea spinella (C. Ag.) Kütz. Tab. Phycol. 18: 9. 1868.

St. Kitts: Frigate Bay, coll. Proctor no. A–3168. St. Lucia: Vigie Point, coll. Proctor no. A–2821. Range from Bermuda to Brazil.

Phyllophoraceae

Gymnogongrus tenuis (J. Ag.) J. Ag. Öfvers. K. Vetensk.-Akad. Förhandl. 6: 88. 1849.

St. Kitts: Frigate Bay, coll. Proctor no. A–3160. Reported from North Carolina, Guadeloupe, Tobago, Brazil, and Uruguay.

Champiaceae

Coelothrix irregularis (Harv.) Børg. Dansk Bot. Ark. 3: 389. 1920.

ST. LUCIA: Vigie Point, coll. Proctor no. A–2824. Range from Bermuda and Florida to British Honduras.

Ceramiaceae

Ceramium nitens (C. Ag.) J. Ag. Spec. Gen. Ord. Alg. 2: 130. 1851.

ST. LUCIA: Vigie Point, coll. Proctor no. A–2823. Within the West Indies this is a slight eastward extension of range. Hitherto known from Bermuda and Florida to Martinique and along the mainland to Colombia.

Ceramium subtile J. Ag. Spec. Gen. Ord. Alg. 2: 120. 1851.

GRENADA: True Blue, coll. Proctor no. A–2695. Range from Bermuda and Florida to Barbados and the Netherlands Antilles.

Centroceras clavulatum (C. Ag.) Mont. *in* Durieu, Flore Algérie 1: 140. 1846.

ST. KITTS: Black Rocks, coll. Proctor no. A–3207. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2787. GRENADA: True Blue, coll. Proctor no. A–2693. Range from Bermuda and Florida to Brazil.

Spyridia aculeata (Schimp.) Kütz. Phyc. Gen. 377. 1843.

GRENADA: Grenada Bay, coll. Proctor no. A–2733. TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 33. Range from Bermuda and North Carolina to Brazil.

Spyridia filamentosa (Wulf.) Harv. *in* Smith, English Fl. 5(1): 337. 1833.

ST. LUCIA: Marquis Bay, coll. Proctor A–2767. GRENADA: Westerhall Point, coll. Proctor nos. A–2686, A–2688. Range from Bermuda and North Carolina to Brazil.

Delesseriaceae

Grinnellia americana (C. Ag.) Harvey var. **caribaea** Taylor, Hancock Atlantic Exped. 2: 127. 1942.

TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 30. The species itself chiefly northern in range, but with the variety known from North and South Carolina, the Netherlands Antilles and Venezuela as well.

Nitophyllum punctatum (Stack.) Grev. Alg. Britt. 79. 1830.

TOBAGO: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 29. Conspicuously large and handsome cystocarpic plants. This is the first well-substantiated record for the West Indies.

Dasyaceae

Heterosiphonia gibbesii (Harv.) Falk. Fauna et Flora Golf. Neapel 26: 653. 1901.

ST. KITTS: North Friars Bay, coll. Proctor no. A–3183. GRENADA: Grenada Bay, coll. Proctor no. A–2725. Range from Bermuda and Florida to Venezuela.

Rhodomelaceae

Falkenbergia hillebrandii (Bornet) Falk. Fauna et Flora Golf. Neapel 26: 689. 1901.

ANTIGUA: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59o. Range from Bermuda and Florida to Brazil.

Polysiphonia ferulacea Suhr in J. Ag. Spec. Gen. Ord. Alg. 2: 980. 1863.

ST. KITTS: Conaree Beach, coll. Proctor no. A–3119; South Friars Bay, coll. Proctor no. A–3177. GRENADA: Grenada Bay, coll. Proctor no. A–2719. Range from Bermuda and Florida to Venezuela.

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Polysiphonia subtilissima Mont. Ann. Sci. Nat. Bot. II, 13: 199. 1840.
St. Kitts: Conaree Beach, coll. Proctor no. A–3152. Tobago: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 37. Range from Bermuda and North Carolina to Brazil.

Bryothamnion triquetrum (Gmel.) Howe, Journ. N.Y. Bot. Gard. 16: 222. 1915.
Anegada Island: Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58f. St. Kitts: Conaree Beach, coll. Proctor no. A–3130. Nevis: Red Cliff, coll. Proctor no. A–3211. Grenada: Grenada Bay, coll. Proctor no. A–2727. Range from Florida to Brazil.

Digenia simplex (Wulf.) C. Ag. Spec. Alg. Rite Cogn. 1: 388. 1822.
Barbuda: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 81. St. Kitts: Black Rocks, coll. Proctor no. A–3202. Antigua: Reeds Beach, coll. Denckla, Smiths.-Bredin no. 119–59h. St. Lucia: Vigie Point, coll. Proctor no. A–2810. Grenada: Grenada Bay, coll. Proctor no. A–2726. Range from Bermuda and Florida to Brazil.

Murrayella periclados (C. Ag.) Schmitz, Ber. Deutsche Bot. Ges. 11: 227. 1893.
Grenada: True Blue, coll. Proctor no. A–2692; Westerhall Point, coll. Proctor no. A–2687. Range from Bermuda and Florida to French Guiana.

Bostrychia tenella (Vahl) J. Ag. Spec. Gen. Ord. Alg. 2: 869. 1863.
Grenada: Westerhall Point, coll. Proctor no. A–2684. Range from Bermuda and Florida to Brazil.

Dipterosiphonia dendritica (C. Ag.) Schmitz in Engler & Prantl, Nat. Pflanzenf. 1(2): 463. 1897.
St. Lucia: Marquis Bay, coll. Proctor no. A–2769. On *Corallina officinalis*, so crowded and mosslike that the typical branch arrangement was seldom seen. This is the easternmost and only the second record in the West Indies, it having been reported from Beata Island by Børgesen.

Amansia multifida Lamour. Nouv. Bull. Sci. Soc. Philom. 1: 332. 1809.
Nevis: Near Red Cliff, coll. Proctor no. A–3218. Range from Florida to Brazil.

Vidalia obtusiloba (Mert.) J. Ag. Spec. Gen. Ord. Alg., 2(3): 1123. 1863.
Grenada: Grenada Bay, coll. Proctor no. A–2724. Range from Florida to Brazil.

Chondria atropurpurea Harv. Smiths. Contr. Knowl. 5(5): 22. 1853.
Grenada: Grenada Bay, coll. Proctor no. A–2732. The easternmost record within the West Indies. Range from Bermuda and North Carolina to Brazil.

Chondria littoralis Harv. Smiths. Contr. Knowl. 5(5): 23. 1853.
St. Kitts: Conaree Beach, coll. Proctor no. A–3154, an exceptionally attenuate form. Range from Bermuda and North Carolina to Colombia.

Chondria tenuissima (G. & W.) C. Ag. Synop. Alg. Scand. xviii. 1817.
Tobago: Man-of-War Bay, coll. Cowan, Smiths.-Bredin no. 32. The easternmost record within the West Indies. Range hitherto from North Carolina to Guadeloupe and Venezuela.

Waldoia nov. gen.

Laminae planae alterne marginaliter conformiter ramosae, ecostatae, cellulis axialibus non perspicuis per nonnulla fila rhizoidea circumdatis,

cellulis pericentralibus non perspicuis; tetrasporangia in stichidiis simplicibus cylindricis super superficiem axium ramorumque ordinariorum dispositis; pericarpi sessiles aut breviter stipitati, in superficie axium ramorumque ordinarium dispositi. Species typicum: *Waldoia antillana*.

Plants with flat blades, alternately marginally conformably branched, ecostate, the axial cells obscure. Tetrasporangia in simple cylindrical stichidia borne over the surfaces of ordinary axes and branches. Pericarps sessile or briefly stalked, borne on the surfaces of ordinary axes and branches.

Waldoia antillana nov. sp. PLATE 3, FIGURES 1, 2; PLATE 4, FIGURE 2

Plantae ex haptero crasse fibroso parce ramoso, in laminis primariis lineari-lanceolatis ecostatis gradatim expansae, laminis per altitudinem plantae totam plerumque extensis, usque ad 4–7 mm. lat.; plantae bis vel ter abunde ramosae; tetrasporangia in stichidiis ad 4–5 mm. longis, 250–400 μ diam., subcylindrica; pericarpi super ramos laterales atque versus extremitates axis primarii dispersi, rotundati, ca. 0.5 mm. diam., ostiolo paululum producto.

Plants to 13 cm. high (perhaps more), rose-red to dull purplish, soft, closely adherent to paper except at the base, arising from a sparingly branched coarsely fibrous holdfast, this giving rise to a few erect, foliar axes; axes very briefly terete below, the stalklike portion 2–15 mm. long, sometimes with a few terete or flattened proliferations, gradually expanded to the primary linear-lanceolate ecostate blades, these generally extending the full height of the plant and becoming 4–7 mm. broad, the margins slightly undulate-crenate, the apex somewhat narrowed but the tip obtuse to retuse; growth from an evident apical cell somewhat projecting or sunken in the apical notch (if present), and surrounded by a few obsolescent trichoblasts. Fronds abundantly 2- or 3-times branched, the branches, marginal, alternate, the branch attachments subterete to flat but contracted, the bases obtusely tapered, the branches otherwise like the primary axis. Tetrasporangia in notable stichidial branchlets scattered over the faces of the blades, often in abundance, to 4–5 mm. long, 250–400 μ diam., at first subconical, becoming subcylindrical with a slightly contracted base and briefly tapered tip, the sporangia formed progressively near the growing point and soon discharged. Pericarps scattered over the lateral branches and toward the ends of the primary axes, superficial, sessile, or contracted below and briefly stalked, rounded, about 0.5 mm. in diameter, the ostiole slightly produced. Spermatangial plants not seen.

Type in the U.S. National Herbarium, collected in Man-of-War Bay, Tobago, British West Indies, April 7, 1959, by Richard S. Cowan (no. 39, tetrasporangial plants).

These plants represent a particularly strange and unexpected addition to the Caribbean flora, for the small and specialized genus *Cladhymenia* to which they at first seemed to belong is primarily a Pacific one. Once before the writer hesitantly assigned some sterile Colombian material to *Cladhymenia*, and naturally one must consider the possibility that the same species is represented in both collections. There is little about the histological characters to distinguish these plants: The cortex cells in surface view seem about one-third broader in the older parts of these Tobagan specimens. It is even more difficult to recognize the primary axial cell and pericentral cells than in *C. lanceifolia.* What probably is the primary axis seems to be surrounded by a few irregular small elements rhizoidal in nature, and the large cells immediately outside these are not regular in number or position. The Tobagan plants are also far more elegantly branched, with longer and more symmetrical axes than the plants from Colombia, which do not adhere to paper except in the youngest proliferations. The possibility remains that the Colombian specimens are fragmentary and proliferous basal portions of old plants. However, the aspects of the two are so very different, as may be seen by comparing the figures of *C. lanceifolia* (Taylor 1942, *pl. 19*) with those given here of *Waldoia antillana,* that it seems safer to describe the new material as a new species rather than to risk confusing the two.

The generic assignment becomes critical now that fertile material is at hand. Until fertile material directly connected with the Colombian plants comes to hand nothing can be done about the status of *C. lanceifolia,* which, on the basis of sterile material, cannot be separated from *Cladhymenia.* Contrariwise, the Tobagan material with the tetrasporangia in simple stichidia all over the surfaces of the blades and not as marginal structures, and with the pericarps sessile or briefly stalked and similarly scattered over the surfaces rather than in marginal projections, is in its reproductive organs very different indeed, although belonging to the same section of the family. It seems appropriate, therefore, to make Tobagan material the type of a new genus *Waldoia,* named in appreciation of the help given by Dr. Waldo Schmitt, and to leave the transfer of the Colombian species name until evidence to justify it appears.[2]

Acanthophora muscoides (L.) Bory, Voy. de la Coquille, Bot. Crypt. 156. 1828.

St. Kitts: Frigate Bay, coll. Proctor no. A–3163. Range from Florida to Brazil, a less common species than the next.

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[2] The writer wishes to express appreciation of the kindness of Professor G. F. Papenfuss in examining representative Tobagan specimens and offering valuable suggestions which in general confirmed the writer's own observations.

Acanthophora spicifera (Vahl) Børg. Bot. Tidsskr. 30: 201. 1910.

BARBUDA: Cocoa Point, coll. Cowan, Smiths.-Bredin, no. 89. ST. KITTS: Black Rocks, coll. Proctor no. A–3197. ST. LUCIA: Pigeon Island, coll. Cowan, Smiths.-Bredin no. 60; Vigie Point, coll. Proctor no. A–2811. GRENADA: Westerhall Point, coll. Proctor no. A–2685. Range from Bermuda and Florida to Brazil.

Laurencia gemmifera Harv. Smiths. Contr. Knowl. 5(5): 73. 1853.

BARBUDA: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 77. NEVIS: Charlestown, coll. Schmitt, Smiths.-Bredin no. 67–58j. Range from Bermuda and North Carolina to Brazil.

Laurencia obtusa (Huds.) Lamour. Mém. du Museum [Paris] 20: 42. 1813.

VIRGIN ISLANDS: Guano Island, coll. Schmitt, Smiths.-Bredin no. 4. BARBUDA: Barbuda Lagoon, coll. Cowan, Smiths.-Bredin no. 91. Range from Bermuda and Florida to Brazil.

Laurencia papillosa (Forssk.) Grev. Alg. Britt. lii. 1830.

ANEGADA ISLAND: Pomato Point, coll. Schmitt, Smiths.-Bredin no. 42–58d (major part). ST. KITTS: Black Rocks, coll. Proctor no. A–3196; Conaree Beach, coll. Proctor no. A–3128; South Friars Bay, coll. Proctor no. A–3178; Frigate Bay, coll. Proctor no. A–3167. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2773. Range from Bermuda and Florida to Brazil.

Laurencia scoparia J. Ag. Spec. Gen. Ord. Alg. 2: 746. 1863.

ST. KITTS: Black Rocks, coll. Proctor no. A–3187; Conaree Beach, coll. Proctor no. A–3128; North Friars Bay, coll. Proctor no. A–3182. ST. LUCIA: Marquis Bay, coll. Proctor no. A–2772; Vigie Point, coll. Proctor no. A–2803. Range from Jamaica to Brazil.

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THE LICHEN FAMILY GRAPHIDACEAE IN MEXICO

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THE LICHEN FAMILY GRAPHIDACEAE IN MEXICO

By Michael Wirth and
Mason E. Hale, Jr. [1]

Introduction

The Graphidaceae form a large but very poorly known family of corticolous, crustose lichens widely distributed in tropical regions. The senior author has long had an interest in studying this group, and during his tenure at the Smithsonian Institution as a research assistant, in 1960–61, was afforded the opportunity to carry these plans forward. It was decided that a revision of the Graphidaceae of Mexico would be a realistically delimited area of study. Mexico is known to have a rich tropical flora, and large representative collections are available for study, including some collections made by the junior author and T. R. Soderstrom in southern Mexico and the Pringle material from central Mexico.

In the initial stages of the study it became obvious that type specimens of extra-Mexican species would have to be examined, especially in view of the extensive synonymy that was to be anticipated in a family which has never been treated monographically. To this end, types of many species described by Krempelhuber, Müller-Argau, Nylander, and Vainio were examined. Altogether types of more than 100 taxa were critically investigated. Unfortunately few of the species described by Fée in 1824 were available, and in most cases the current concepts of these species had to be followed. Redinger's (1933, 1935) excellent revisions of Brazilian Graphidaceae have been especially helpful in this respect.

The Fée types are reportedly preserved at Rio de Janeiro, but inquiries there failed to uncover more than a few species. It has been learned recently that a nearly complete series of isotypes was prepared by Müller-Argau when he revised the Fée species in 1887. These specimens are still in the process of being curated and incorporated

[1] Based on research partially supported by a grant from the National Science Foundation.

into the general cryptogamic herbarium at Geneva. Because of their fundamental importance in the taxonomy of the Graphidaceae and other tropical crustose families, Fée's many species must eventually be carefully typified, and it is hoped that this can be accomplished in the near future.

The circumscription of the Graphidaceae is far from settled (cf. Santesson, 1952, pp. 44, 45), because this family once included a number of ascolocular genera (e.g., *Opegrapha*). As here considered, the family is taken to include all those ascohymenial lichens which have lirelliform ascocarps and lack columellae. By this definition, all the ascohymenial representatives of the Chiodectonaceae should probably be referred to the Graphidaceae. This transfer would actually be in accord with natural relationships, as the so-called stromata of the Chiodectonaceae are not significantly different from the ascocarps of the Graphidaceae. It is not uncommon to find individuals with polymorphic ascocarps such that half of an individual can be referred to one family and half to another. *Sarcographa* (Chiodectonaceae) and *Phaeographis* (Graphidaceae) are so closely allied as to make identification at the species level nearly impossible. The lack of consistency in the formation of stromatoid tissue renders the taxonomy of this group very unclear.

Another major difficulty in delimiting the Graphidaceae becomes evident in considering the related family Thelotremataceae, which is usually characterized by having round ascocarps. Some species in the Thelotremataceae have lirelline ascocarps and show variations paralleling those of the Graphidaceae. In addition, some species in the Graphidaceae (e.g., *Graphina confluens* (Fée) Müll. Arg., *G. hemisphaerica* (Vain.) Zahlbr., and *G. quassiaecola* (Fée) Müll. Arg.) exhibit a definite trend towards the formation of round apothecia, structurally identical with those of many thelotremataceous species. A further link can be found in *Graphina macrospora* (Kremplh.) Müll. Arg., in the ascocarps of which are found columellae (cf. fig. 4), usually considered as being restricted to the Thelotremataceae. It is obvious that the shape of the ascocarps is not a valid criterion for separating families and perhaps not even useful for generic delimitation. Much more work on developmental anatomy is necessary before workable families can be erected in these lichens.

The genera of the Graphidaceae are traditionally separated on the bases of algal host, spore color, and spore septation. As Santesson (1952, p. 46) has already pointed out, the genus of algal host is a poor criterion in lichen taxonomy. Both spore color and septation are characters of sometimes limited usefulness in generic delimitation. There are groups of species which have constantly colorless, thin-walled, four-celled spores. There is also a natural group of species

with brown, thick-walled, five- to eight-celled spores. However, in other cases spore color and septation seem to be too variable to serve as major taxonomic features; they are often so unstable as to vary within a single specimen. See the discussions under *Graphina acharii* (p. 72) and *Phaeographina chrysocarpa* (p. 102) for a more detailed account of this variability.

The genus *Melaspilea*, usually separated from *Graphis* by the cubic shape of the spore locules, has a perfect counterpart in the *Graphis* species allied to *G. turbulenta* Tuck. The spores in both of these groups are almost always 2-locular and identical, and separating them into two genera is quite unrealistic. The spores of *Melaspilea* often show variation in color from hyaline to dark brown.

Within the four major genera, *Graphis*, *Phaeographis*, *Graphina*, and *Phaeographina*, parallel subgeneric divisions into sections have been established. These have been summarized, for the most part, by Redinger (1933, 1935), who recognized 50 of these taxa. The characters used in sectional analysis are discussed below. They have proved in our studies to be highly inconstant and intergrading, and a single species or occasionally a single individual may be placed in either of two sections with equal facility.

1. Degree of excipular carbonization. This character is often useful on the specific level, but it varies considerably. It is difficult to divide the species objectively into major groups on the criteria of "exciple entirely black," "exciple black above and colored below," or "exciple completely brown or colorless." Too often random carbonization will occur in portions of an exciple (see figs. 8, 10–13). In addition, it is not easy to delimit brown exciples from black exciples, since the pigmentation often intergrades.

With regard to carbonization, it might be mentioned that it is necessary to cut sections of the ascocarps as thin as possible, since uncarbonized tissues will often appear black in thick sections. Included air will also cause the same appearance. We have found that the best results are obtained when Hoyer's solution (Anderson 1954) is used as the mounting and clearing agent and the slides are allowed to stand on a warming plate for at least a half hour. This medium clears tissues quickly and completely, yet it does not change their relative densities. Moreover it is an excellent solution in which to demonstrate colored spores, as these do not decolorize at all, while the hymenium and asci become transparent and clear.

2. Open or closed exciples. Exciples in the Graphidaceae cannot always be easily separated into two major types on the basis of whether they are closed basally or not (see figs. 31–35). Even in species with highly carbonized exciples it is often possible to find the basal portion turning brown and uncarbonized or becoming so thin as to be closed

in one part of an ascocarp and open in another. It is difficult to determine where apothecial tissue ends and where thallus or substratum begins in species with only partial carbonization or no darkening of the exciple. In fact, we have been unable to state for many type specimens whether the exciple is open or closed, because one section of an ascocarp would differ from the next.

3. Striation of the exciple. The degree to which excipular labia become striate is not a constant feature. Many individuals exhibit labia which are entire in some portions, crenate in others, and striate elsewhere (see figs. 14–16, 24–27). Furthermore the number of lamellae or dentations in prominently striate labia seems to be correlated with age.

4. Convergent or divergent labia. This character is only partially useful as a taxonomic criterion. Some species have constantly open disks; others vary from rimiform at one stage to gaping at others. (See figs. 31–35, 66, 69, and 70.)

All four of the above characters are useful in separating individual species but intergrade far too much to be maintained as sectional criteria. We have therefore decided to dispense with sectional names in this study. It is impractical to use the myriad sections now recognized until the genera of the Graphidaceae are monographed and new sectional criteria established.

In investigating the Graphidaceae of Mexico, we have attempted to assay specimens for lichen acids whenever possible. Unfortunately type material was sometimes too fragmentary to extract, and color reactions alone had to be used. A KOH+ red reaction is often caused by an unknown substance that does not recrystallize in G.A. o-T. Stictic acid may give a KOH— reaction even though a microchemical test with G.A. o-T. is positive. This color reaction is complicated when the thallus is discolored or the acid is present in seemingly very low concentration.

Salacinic acid and atranorine, so common in foliose lichens, appear to be very rare in the Graphidaceae. On the other hand, norstictic acid (KOH+ red) seems to be one of the most common acids. In addition to atranorine, stictic acid, norstictic acid, and salacinic acid, we have demonstrated zeorine, lecanoric acid, protocetraric acid, lichexanthone, fatty substances, and several unknown acids.

There seems to be some correlation between chemistry and anatomical features in a few species. *Graphina parilis*, with 8-spored asci and stictic acid, and *G. sulcata*, with 2- to 6-spored asci and norstictic acid, are examples of this phenomenon. In other species there are two or more chemical strains but with no apparent correlation with anatomy. It remains to be seen exactly what taxonomic importance chemical components will have in this family. With the

exception of *Rhizocarpon* (Runemark, 1956), no crustose groups have been studied chemically. To aid other investigators we have appended on page 112 a list of type specimens which we have examined for color reactions and lichen acids.

In this study we have described five new species, *Graphina peplophora*, *Graphis glaucopis*, *G. stygioarachnoidea*, *Phaeographina strigops*, and *P. elliptica*, and made two new combinations, *Graphina mexicana* (Zahlbr.) Wirth & Hale and *Phaeographina leiogrammodes* (Krempelh.) Wirth & Hale.

For the prompt loan of valuable type specimens we are very much indebted to Dr. Sten Ahlner (Naturhistoriska Riksmuseum, Stockholm), Dr. R. Alava (Botanical Institute, Turku), Dr. Charles Baehni (Conservatoire et Jardin Botaniques, Geneva), Dr. I. Mackenzie Lamb (Farlow Herbarium, Cambridge), Dr. Josef Poelt (Botanische Staatssammlung, Munich), Dr. K. Rechinger (Naturhistorisches Museum, Vienna), Dr. C. T. Rizzini (Jardim Botânico, Rio de Janeiro), Dr. H. Roivainen (Botanical Museum, Helsinki), Dr. Robert Shaffer (Herbarium, University of Michigan, Ann Arbor), and Dr. H. W. Vogelmann (University of Vermont, Burlington).

Key to Species

1. Ascocarps cinnabar red . . . . . **39. Phaeographina chrysocarpa**
1. Ascocarps brown, black, gray, or white.
   2. Spores always 2 locular . . . . . **36. Melaspilea polymorpha**
   2. Spores 3 to many locular.
      3. Spores transversely 3 septate (4 locular) only, no other septae present.
         4. Spores brown, thick walled.
            5. Ascocarps dendritically branched; exciple entirely black; disc black or gray . . . . . **45. Phaeographis sericea**
            5. Ascocarps more or less unbranched; exciple red-brown, black only in spots; disc brown . . . . . **57. Phaeographis inusta**
         4. Spores hyaline (except when senile or obviously shrunken), thin walled.
            6. Ascocarps sessile; exciple black, covered by a white C+ red veil. **22. Graphis afzelii**
            6. Ascocarps more or less immersed, C—; exciple uncarbonized.
               7. Exciple well developed, much thickened below; ascocarps lirelline, immersed . . . . . **29. Graphis grammatica**
               7. Exciple poorly developed, bark-inspersed; mature ascocarps elliptical, with flaring margins . . . . . **32. Graphis platycarpella**
      3. Spores transversely 4 or more septate or muriform.
         8. Spores transversely septate only, never muriform or apically biocellate.
            9. Spores brown, thick walled.
               10. Ascocarps sessile, prominent, often stromatoid; exciple entirely black, closed, much thickened below; hymenium with oil droplets . . . . . **44. Phaeographis exaltata**
               10. Ascocarps somewhat emergent, never sessile, thalline border never prominent or stromatoid; exciple lacking or not greatly thickened below; hymenium not inspersed.

11. Ascocarps rarely branched, slender, elongate; exciple black, dimidiate . . . . . **46. Phaeographis sexloculata**
11. Ascocarps dendritically branched, to 0.4 mm. wide; exciple closed, brown and black . . . **43. Phaeographis dendritica**

9. Spores colorless (brownish when senile or shriveled), thin walled.
12. Exciple totally uncarbonized, with no black or very dark brown tissues.
13. Labia lightly sulcate, sulcae externally concealed by a smooth thalline veil.
14. Ascocarps slender, lirelline . . . . . **30. Graphis implicata**
14. Ascocarps rotund to elliptical . . **7. Graphina hololeucoides**
13. Labia entire.
15. Ascocarps dendritic to asteroid, immersed; spores muriform at maturity . . . . . **21. Graphina virginea**
15. Ascocarps more or less unbranched, elliptical, arranged in rows, subsessile; spores never muriform.
28. Graphis glaucopis

12. Exciple with black or dark tissue (often limited to the labial apices).
16. Exciple carbonized laterally only (often the labial apices only), pale or light brown below.
17. Labia consisting of partially free carbonized hyphae; exciple otherwise totally decolorized.
34. Graphis stygioarachnoidea
17. Labia entire or striate but never composed of free individually carbonized hyphae.
18. Labia distinctly striate.
19. Spores up to 30μ long.
20. Ascocarps quite sessile, prominent; exciple heavily inspersed with crystals . . **26. Graphis endoxantha**
20. Ascocarps emergent to subsessile; exciple without crystals . . . . . **33. Graphis proserpens**
19. Spores more than 30μ long, usually much longer.
21. Exciple and labia black; sulcae few.
49. Graphis striatula
21. Exciple partially brown; sulcae many, deep, black; spores finally muriform . . . **13. Graphina parilis**
18. Labia never striate.
22. Labia barely fuscescent, never highly carbonized; exciple pale, more or less closed; ascocarps elliptical.
28. Graphis glaucopis
22. Labia distinctly carbonized; exciple more or less dimidiate; ascocarps lirelline.
23. Ascocarpa distinctly pruinose . **24. Graphis caesiella**
23. Ascocarps black, epruinose.
48. Graphis scripta group
16. Exciple carbonized laterally and below or dark brown below.
24. Ascocarps caesiopruinose; labia more or less divergent.
35. Graphis subamylacea
24. Ascocarps black or covered by the thallus, epruinose; labia more or less convergent.

25. Spores very long and slender, vermiform; ascocarps concolorous with the thallus; labia denticulate.
50. Graphis vermiformis

25. Spores not vermiform; ascocarps showing some traces of black.

26. Labia more or less entire.

27. Thallus KOH−, P−; labia always lightly crenate or denticulate . . . . . **31. Graphis longula**

27. Thallus KOH+ reddish; labia entire.

28. Ascocarps robust, covered nearly to the apex by a heavy thalline veil; spores 2–6 per ascus, over 75μ long; no acids demonstrated.
23. Graphis anguilliformis

28. Ascocarps slender, *Opegrapha*-like, black; spores 8 per ascus, under 30μ long; norstictic acid present.
25. Graphis desquamescens

26. Labia denticulate to striate.

29. Exciple distinctly carbonized throughout.

30. End locules of some spores biocellate.
1. Graphina acharii

30. End locules of all spores entire.

31. Ascocarps robust, about 0.6 mm. wide; labia deeply striate . . . . **27. Graphis flexibilis**

31. Ascocarps slender, usually less than 0.4 mm. wide; labia crenate to denticulate.
31. Graphis longula

29. Exciple open or brown below.

32. Spores eventually muriform; stictic acid present.
13. Graphina parilis

32. Spores never muriform.

33. Exciple dark brown; labia dissected into free, disconnected black lamellae.
33. Graphis proserpens

33. Exciple completely black; labia confluent with the rest of the exciple.

34. Spores 2–6 per ascus, more than 40μ long; exciple usually closed below, at least by a thin carbonized strip; ascocarps flexuose, occasionally branched.
31. Graphis longula

34. Spores 8 per ascus, less than 45μ long; exciple open below, rarely almost closed; ascocarps *Opegrapha*-like, usually unbranched, straight.
49. Graphis striatula

8. Spores transversely and longitudinally septate (sometimes only in the apical portions).

35. Exciples with no carbonized tissue.

36. Spores one per ascus.

37. Ascocarps and thallus concolorous.

38. Labia striate; exciple pale below the hymenium.
3. Graphina bipartita

38. Labia entire; exciple black or very dark below the hymenium.
4. Graphina confluens

37. Ascocarps (at least the disc) darker than the thallus.
39. Hymenium with prominent crystalline inspersions.
42. Phaeographina elliptica

39. Hymenium without crystals.
56. Phaeographina scalpturata

36. Spores 2–8 per ascus.
40. Labia distinctly striate, the striae often externally concealed by a thalline covering.
41. Ascocarps subsessile, lighter than the thallus.
42. Ascocarps slender, quite flexuose; not mealy.
2. Graphina balbisii

42. Ascocarps robust, round to straight, mealy.
43. Ascocarps round to elliptical; spores 4–6 per ascus.
7. Graphina hololeucoides

43. Ascocarps elongate; spores 2–4 per ascus.
14. Graphina peplophora

41. Ascocarps more or less immersed, concolorous with the thallus.
44. Exciple basally continuous with the thallus by a carbonized band; spores 4–8 per ascus. . **19. Graphina triangularis**

44. Exciple not basally continuous, colorless below; spores 8 per ascus . . . . . **12. Graphina palmeri**

40. Labia entire, not striate.
45. Exciple basally continuous with thallus by a band of more or less carbonized tissue; ascocarps dendritic, fused; disc wide, pruinose . . . . . **8. Graphina insignis**

45. Exciples discrete, never basally continuous.
46. Spores distinctly brown; exciples red-brown, distinctly closed; labia more or less divergent.
47. Ascocarps emergent, with a prominent thalline margin; discs pruinose; spores more than 25μ long.
37. Phaeographina asteroides

47. Ascocarps immersed, without a thalline margin; discs black; spores less than 22μ long.
41. Phaeographina strigops

46. Spores colorless (except brownish when senile); exciples pale to fuscescent, barely closed or open; labia more or less convergent.
48. Spores more than 50μ long, usually much more; ascocarps dendritically branched, never fissurine.
21. Graphina virginea

48. Spores less than 40μ long; ascocarps rarely dendritically branched, often fissurine.
49. Ascocarps intricately intertwined and grouped, gaping.
11. Graphina mexicana

49. Ascocarps never intricately intertwined.
50. Ascocarps KOH− or pale, short, more or less unbranched, gaping; labia dark brown or fuscescent.
20. Graphina virginalis

50. Ascocarps KOH+ purple to black, long slender, branched, usually not gaping; labia pale or reddish. . . . . **16. Graphina scolecitis**

35. Exciple with carbonized tissue.
51. Spores one per ascus.
52. Labia striate.
53. Exciple closed, entirely black . . . **10. Graphina macella**
53. Exciple more or less open, pale or brownish, only the labia carbonized . . . . . **3. Graphina bipartita**
52. Labia entire.
54. Exciples closed, often basally continuous; ascocarps round to lirelline . . . . . **4. Graphina confluens**
54. Exciples more or less open, never basally continuous; ascocarps lirelline.
55. Disc very wide, pruinose . . . . **40. Phaeographina** sp.
55. Disc narrow, epruinose . . . . . **6. Graphina hiascens**
51. Spores 2–8 per ascus.
56. Exciples basally continuous by a more or less carbonized layer.
57. Labia striate, pale; spores over 45μ long.
19. Graphina triangularis
57. Labia entire, brown; spores up to 15μ long.
8. Graphina insignis
56. Exciples not basally continuous.
58. Labia divergent, disc very wide.
38. Phaeographina caesiopruinosa
58. Labia more or less convergent, disc rimiform.
59. Exciples mostly brown or pale, only the labia fuscescent or darker brown.
60. Labia striate; ascocarps not fissurine; spores more than 45μ long . . . . . **12. Graphina palmeri**
60. Labia entire; ascocarps fissurine at maturity; spores less than 40μ long . . . . . **20. Graphina virginalis**
59. Labia and/or exciples distinctly carbonized.
61. Labia entire, sinuous or barely striate.
62. Ascocarps intricately intertwined in discrete groups, naked, sessile, black.
18. Graphina sulcatula var. **conglomerata**
62. Ascocarps not intertwined in discrete groups.
63. Ascocarps asteroidly branched; labia sulcate in some portions; exciple dimidiate.
5. Graphina elongata
63. Ascocarps not asteroidly branched; labia substriate to sulcate.
64. Exciple more or less open, brown or pale below.
13. Graphina parilis
64. Exciple closed, entirely black.
9. Graphina inturgescens
61. Labia distinctly dentate or sulcate.
65. Ascocarps asteroidly branched.
5. Graphina elongata
65. Ascocarps never asteroidly branched.
66. Exciple thick and more or less completely carbonized below the hymenium.
67. Spores 65–150μ long, commonly muriform only in the end cells; labia regularly striate.
1. Graphina acharii

67. Spores 30–45μ long; labia irregularly dissected.
15. Graphina rimulosa

66. Exciple brown or lacking below the hymenium.
68. Exciple completely black laterally, dimidiate and brownish below the hymenium; labia lightly few sulcate . . . . **47. Graphina sophistica**

68. Exciple partially brown laterally; labia more or less free, black, embedded in the brownish exciple.
69. Labia very irregularly dissected and lacerate.
15. Graphina rimulosa

69. Labia lamellar, regular.
70. Spores 2–6 per ascus, with 5–8 transverse septae, 20–35μ long; norstictic acid present.
17. Graphina sulcata

70. Spores 8 per ascus, with 12–20 transverse septae, 28–80μ long; stictic acid.
13. Graphina parilis

1. Graphina

1. Graphina acharii (Fée) Müll. Arg. Mem. Soc. Phys. Hist. Nat. Genève 29, no. 8:38. 1887. FIGURE 1
Graphis acharii Fée, Essai Crypt. Ecorces, 39, *pl. 10, fig. 4*, 1824. Type: South America (not seen).

Thallus smooth to rough, continuous. Ascocarps sessile, large, very variable, covered up to or nearly to the apex by a thalline margin; exciple black, closed; labia convergent, striate. Spores 2–8 per ascus, 18–30×1–6 locular, colorless or brownish, 15–25×65–150 μ.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.[2]

Specimens examined: Chiapas: El Suspiro, *Hale* 20230, 20237, north of Tuxtla Gutiérrez, *Hale* 20067, Lagos de Monte Bello, *Hale* 20437 (US). Morelos: Cuernavaca, *Pringle* 429, 15373 (FH, VT). Tamaulipas: Tamasopo, *Pringle* 34a (FH), 166 p.p. (FH, MICH). Vera Cruz: South of Catemaco, *Hale* 19821 (S, US), Orizaba, *Pringle* s.n. (FH, MICH), Jalapa, *Pringle* 15398 (FH, MICH, VT).

Graphina acharii shows an enormous amount of variation in ascocarp size and shape and spore septation and color. The ascocarps range from elongate and black above to oryzaeform and totally covered with thalline tissue. The spores may be muriform throughout or only geminate at the ends. The completely muriform spores are quite often pale brownish. Considering these characters, we find it difficult to maintain the entity originally described by Krempelhuber as *Graphis inturgescens*, which differs from *Graphina acharii* only in the subentire labia.

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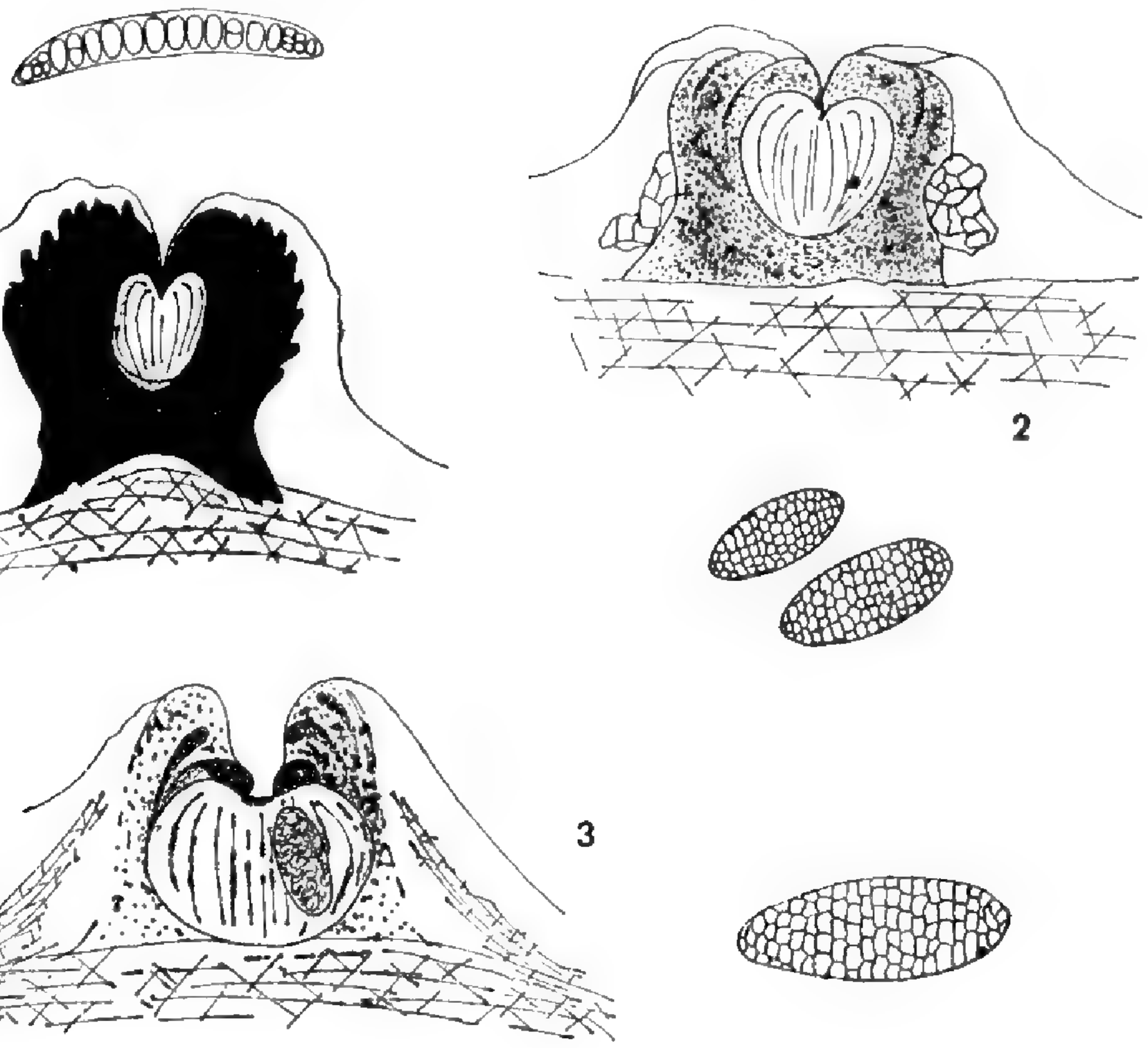
[2] In these lists of the species, all specimens examined contained the substances indicated under the heading "Reactions" unless otherwise indicated.



FIGURES 1–3.—1. *Graphina acharii* (Fée) Müll. Arg. (*Pringle* 166 p.p.). 2. *G. balbisii* (Fée) Müll. Arg. (*Pringle* 242). 3. *G. peralbida* (Nyl.) Zahlbr. (holotype, *Pringle* 222).

Graphina acharii apparently exhibits the same type of variation that is found in *Phaeographina chrysocarpa*. A broad treatment of the species will be necessary, based on careful examination of the holotype and the types of several related species, *Graphis illinata* Eschw. in Mart., *Phaeographis cerviculata* Redgr., *Graphina vestitoides* Fink, *G. dealbata* (Nyl.) Müll. Arg., and *G. heteroplaca* Müll. Arg.

2. Graphina balbisii (Fée) Müll. Arg. Flora 65:397. 1882. FIGURE 2

Graphis balbisii Fée, Essai Crypt. Ecorces 48, *pl. 10, fig. 5*, 1824. Type: South America (not seen).

Thallus continuous, smooth to irregular. Ascocarps lighter in color than the thallus, usually unbranched, quite slender and flexuose, 1–4 mm. long; disc rimiform; exciple red-yellow, closed, about 250 μ high; labia 1–3 sulcate, convergent. Spores 4–5 per ascus, 13–18×4–6 locular, 18–26×50–110 μ, occasionally somewhat brownish.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.

Specimens examined: Morelos: Cuernavaca, *Pringle* 242 (VT), 426 (MICH).

Redinger (1933, p. 61) placed *Graphina balbisii* and his variety *monospora* in section *Chlorographina*. However, the type of var. *monospora*, and what may be a fragment of the type of *Graphis balbisii* in MICH, both show distinctly striate labia, as Müller (1887, p. 45) had earlier observed for the species.

Pringle 119, reported by Eckfeldt (1892, p. 252) as "Graphis balbisii Nyl.," is referable to *Graphis implicata* Fée.

3. Graphina bipartita Müll. Arg. Rev. Mycol. 10:19. 1888. FIGURE 3

Graphis peralbida Nyl. Lich. Trop. Singapore et Labuan 42. 1891. Holotype: Las Palmas, San Luis Potosí, Mexico, *Pringle* 222 (H, isotypes in FH, VT).

Graphina peralbida (Nyl.) Zahlbr. Cat. Lich. Univ. 2:418. 1923.

Holotype: Assuncion, Paraguay, *Balansa* 1876 (G).

Thallus nitid to minutely roughened, continuous or somewhat fissured. Ascocarps immersed to emergent, unbranched or nearly so, usually concolorous with the thallus, 1–3 mm. long, about 0.4 mm. wide, flexuose and somewhat intricate; disc very narrow, occasionally blackish; exciple open or partially closed; labia convergent, with 1–3 dark or carbonized striae; hymenium 60–100 μ high. Spores one per ascus, densely muriform, hyaline or brownish, 23–40×60–100 μ.

Reactions: KOH+ reddish, norstictic acid.

In the type description, *G. peralbida* is cited from a Mexican collection by Eckfeldt. One year later, Eckfeldt (1892, p. 252) listed *Graphis peralbida* giving Pringle as the collector. As the holotype specimen (H) is marked as coming from San Luis Potosí and is identical with *Pringle* 202 in FH and VT, it is certain that this collection by Pringle is the type and that Nylander made a mistaken reference in his publication. This type is identical with *Graphina bipartita*, which is probably pantropical, as we have seen several specimens from Hawaii.

4. Graphina confluens (Fée) Müll. Arg. Mem. Soc. Phys. Hist. Nat. Genève 29, no. 8:45. 1887. FIGURES 4–13

Arthonia confluens Fée, Essai Crypt. Ecorces 55, *pl. 14, fig. 5*, 1824. Type: South America (see below).

?Graphis delicatula Fée, Bull. Soc. Bot. France 21:28. 1874. Syntypes: Brazil, *Glaziou* 3226, 3396 (not seen; see following species).

Graphis macrospora Krempth. Flora 59:380. 1876. Syntypes: Brazil, *Glaziou* 3379, 3380 (M), 3226 (not seen; this is also a syntype of *G. delicatula*).

Graphina macrospora (Krempth.) Müll. Arg. Flora 71:508. 1888.

?Graphina platygrapta Müll. Arg. Flora 71:495. 1888. Type: Cayey, Puerto Rico, *Sintenis* 25 p.p. (not seen).

Graphina epiglauca Müll. Arg. Bull. Soc. Bot. Belg. 32:152. 1893. Type: Costa Rica, *Pittier* (US, isotype).

Graphina collatinensis Redgr. Hedw. 73:59. 1933. Type: Collatina, Espiritu Santo, Brazil, *Bornmüller* 13 (not seen).

Graphina collatinensis var. *ocellariiformis* Redgr. Ark. Bot. 26A, no. 1:24. 1933. Syntypes: Brazil, *Malme* 2351, 2416, 3565, 3576 (S).

Graphina collatinensis var. *lirelliformis* Redgr. Ark. Bot. 26A, no. 1:25. 1933. Holotype: Corcovado, Rio de Janeiro, Brazil, *Malme* 84 (S).

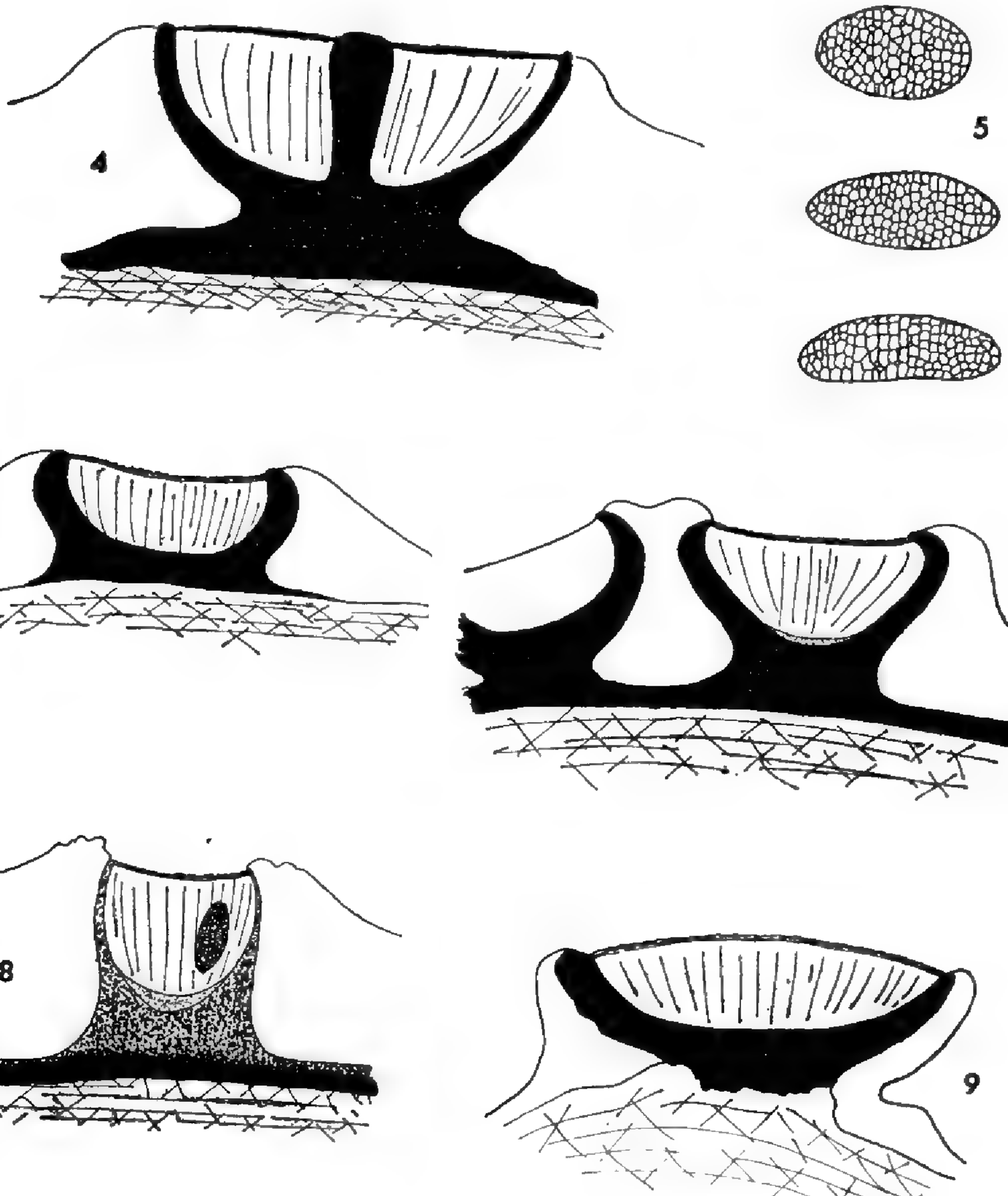
Thallus light colored, continuous, thin to quite thick, often desquamescent. Ascocarps very variable in size and shape, immersed to emergent or sessile, round to lirelline, always covered by a thalline margin; disc narrow to wide, lightly to heavily pruinose; exciple

closed, brown or carbonaceous, often basally continuous in a subthalline layer; labia more or less entire, distant, and divergent; hymenium intact or rarely with an incipient columella. Spores one per ascus, densely muriform, hyaline, yellowish, or pale brownish, 25–50× 65–175 μ.

Reactions: See below.

Specimens examined: Chiapas: El Suspiro, *Hale* 20155, 20169 (US). Tamaulipas: Tampico, *Pringle* 8 (W). Vera Cruz: South of Catemaco, *Hale* 19803 (S, US).

Arthonia confluens Fée was based on two specimens, one from South America on *Cinchona* and one from Guadeloupe on *Jacquinia*. Müller



FIGURES 4–9.—4. *Graphina macrospora* (Kremplh.) Müll. Arg. (syntype, *Glaziou* 3379). 5. *G. confluens* (Fée) Müll. Arg. Variation in spore shape. 6. *G. epiglauca* Müll. Arg. (isotype, *Pittier* s.n.). 7. *G. collatinensis* var. *ocellariiformis* Redgr. (syntype, *Malme* 3565). 8. *G. collatinensis* var. *lirelliformis* Redgr. (holotype, *Malme* 84). 9. *G. confluens* (Fée) Müll. Arg. (*Pringle* 8).

discovered that the syntypes were heterogeneous and referred the Guadeloupe specimen to *Opegrapha*. We have examined the same specimen (from Rio de Janeiro) and can confirm that it is an *Opegrapha*. The South American material, which becomes the lectotype, has not been seen by us, but Müller's description leaves little doubt in our minds as to its identity.

Graphina confluens seems to be one of the most variable, complex, and widespread *Graphina* species yet encountered. The entity cuts across generic and family boundaries with a continuous, interrelated series of forms which are difficult to separate. In addition, quite a number of species have been described which are probably additional variants. The difficulties involved in this group may best be summarized by examining the following salient features.

1. The extremes of thallus form in this group are quite distinct. At one end of the spectrum of variants are thin, barely continuous, closely adherent thalli; at the opposite end are those forms with thick desquamescent thalli, often with a basal carbonaceous layer. All intermediate stages can be found. In the related *Graphina platycarpina* Zahlbr. the thallus is areolate.

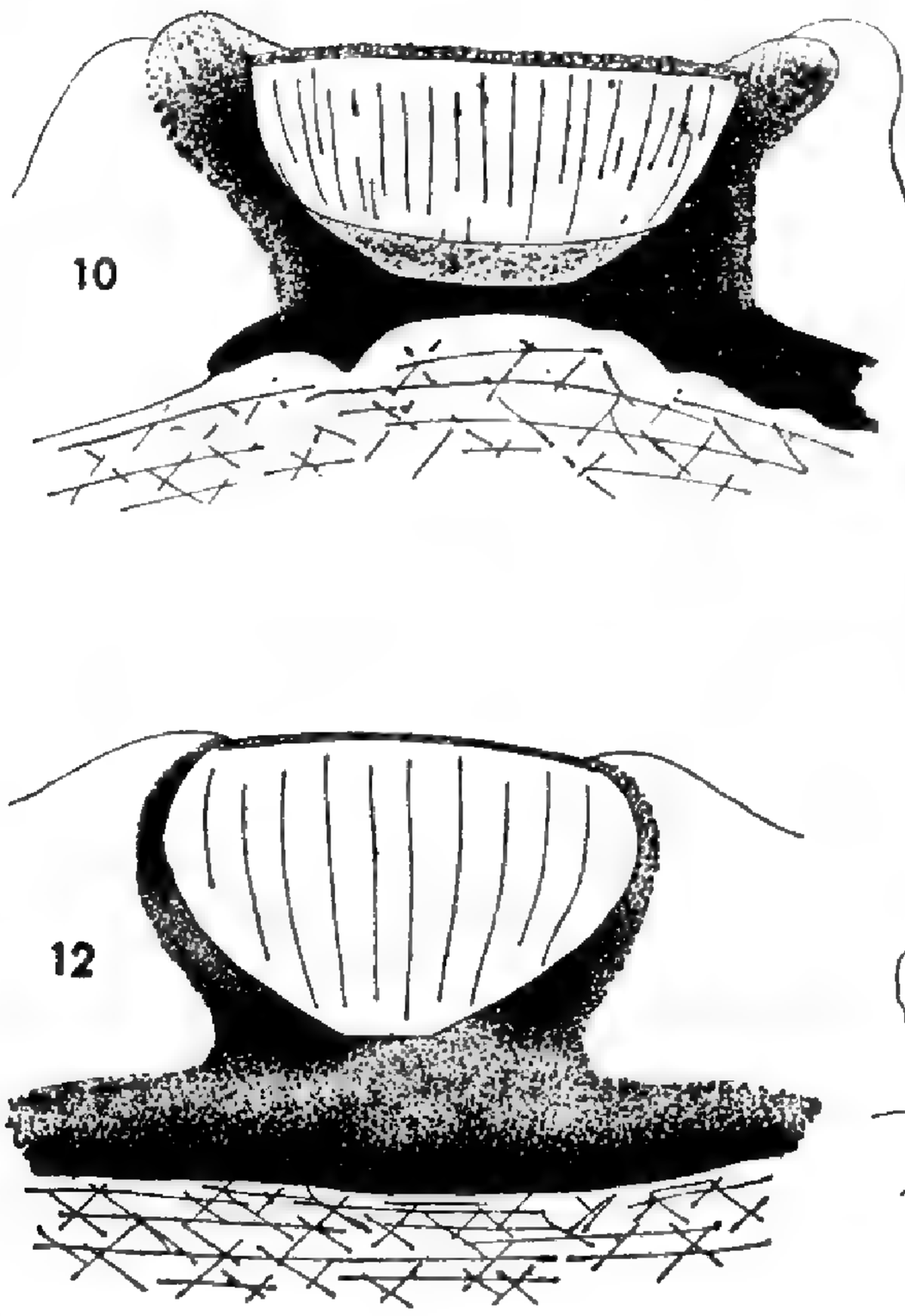
2. The ascocarps vary from completely lirelline to completely round, commonly within the same thallus. Specimens with immersed apothecia-like ascocarps approach the Thelotremataceae very closely. The degree of immersion in the species is highly variable. The extremes are distinct, but the presence of numerous intermediate specimens renders separation nearly impossible.

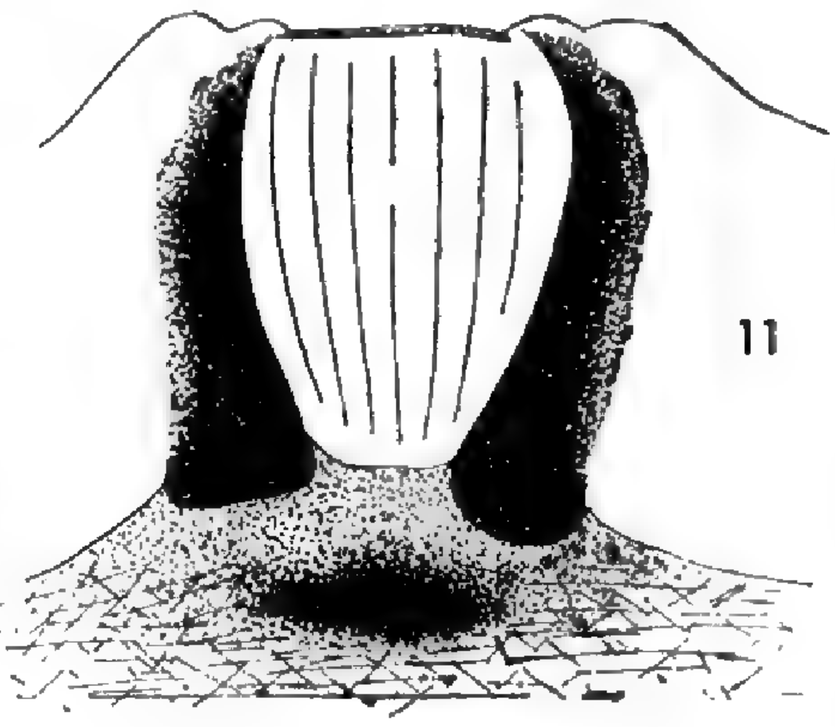
3. The exciples vary in structure from more or less completely carbonized forms (*Graphina epiglauca*, *G. collatinensis* var. *ocellariiformis*, and *G. macrospora*, figs. 4, 6, 7) to entirely brown extremes showing carbonization only in the subthalline layer (*G. collatinensis* var. *lirelliformis*, fig. 8). Between these two extremes one can find exciples which are carbonized only in spots or blackened above and brown below (figs. 10–13).

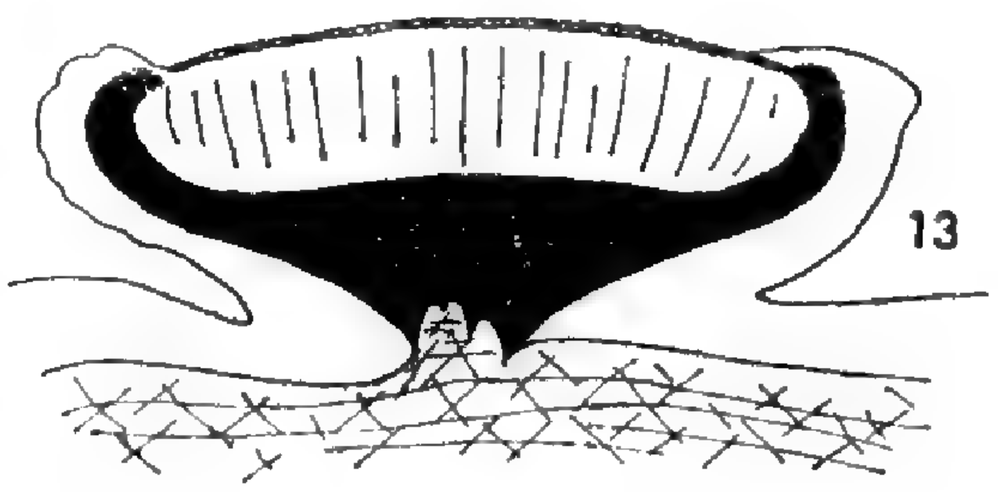
One of the syntypes of *G. macrospora* (*Glaziou* 3379) has exciples which show distinct columellae forming. In all other details of anatomy it is identical with the syntypes of *G. collatinensis* var. *ocellariiformis*. The presence of columellae is not altogether unexpected and provides further evidence of the unity of the Graphidaceae and much of the Thelotremataceae.

4. Spores that are large and densely muriform, with but one per ascus, are characteristic of all individuals of this polymorphic species. However, the spores vary from completely hyaline to yellowish or brownish. It is thus sometimes difficult to decide whether certain specimens should be placed in *Graphina* or *Phaeographina*.

5. The distribution of *Graphina confluens* as here delimited extends







FIGURES 10–13.—10. *Graphina confluens* (Fée) Müll. Arg. (*Wright* 23). 11. *G. confluens* (*Hioram* 5300). 12. *G. confluens* (*Williams* 7102). 13. *Graphis glaucoleuca* Nyl. nom. nud. (*Wright* 4).

from Mexico, Costa Rica, and the West Indies, to Brazil and Africa. There seems to be no correlation between anatomy and distribution.

6. Lichen acids are present in a bewildering array, apparently unrelated to either anatomy or geographic distribution. Acids demonstrated are as follows (the numbers in parentheses indicate number of specimens):

Stictic acid only: Philippines (1).
Stictic acid, lichexanthone, and a fatty substance: Costa Rica (1), Mexico (3), Cuba (3), Jamaica (1), Puerto Rico (2), and Brazil (2).
Stictic acid and an unknown: Puerto Rico (2).
Lichexanthone only: Cuba (1) and Brazil (3).
Lichexanthone, zeorine, atranorine: Brazil (1).
Norstictic acid: Cuba (1) and Brazil (1).

5. Graphina elongata (Vain.) Zahlbr. Cat. Lich. Univ. 2:405. 1923.

FIGURES 14–16

Graphis elongata Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:107. 1890. Holotype: Sitio, Minas Gerais, Brazil, *Vainio* 782 (TUR).
Graphina elongatoradians Fink, Mycologia 19:218. 1927. Holotype: Manatí, Puerto Rico, *Fink* 2049 (MICH). Reactions: KOH+ red, P— (?), o-T—, no acids demonstrated.

Thallus smooth, continuous. Ascocarps slender, semiemergent to subsessile, occurring in large, radiately branched asteroid groups up to 15 mm. in diameter; exciple black, open; labia 1–3 striate, convergent;

hymenium 50 μ high. Spores 2–4 (–6) per ascus, 7–9×1–4 locular, 13–19×25–50 μ.

Reactions: KOH+ red, norstictic acid.

Specimen examined: Chiapas: Lagos de Monte Bello, *Hale* 21069 (US).

The excipular labia of this species are often only faintly striate, and it is necessary to examine sections of several ascocarps to ensure proper identification. The holotype of *G. elongatoradians* differs from that of *G. elongata* only in having somewhat smaller, less emergent ascocarps and in apparently lacking norstictic acid, although the color reaction indicates its presence.

6. Graphina hiascens (Fée) Müll. Arg. Mem. Soc. Phys. Hist. Nat. Genève 29 no. 8:42. 1887. FIGURES 17–20

Opegrapha hiascens Fée, Suppl. Essai Crypt. Ecorces, 25, *pl. 36, fig. 1*, 1837. Type: South America (not seen, isotype at MICH?).

?Opegrapha endochroma Fée, Essai Crypt. Ecorces, 31. 1824. Type: Tropical America (not seen).

Graphis subserpentina Nyl. Acta Soc. Sci. Fenn. 7:465. 1863. Type: Ceylon, *Gardner* (US, isotype).

Graphina subserpentina (Nyl.) Müll. Arg. Bull. Soc. Bot. Belg. 32:152. 1893.

Graphis macgregorii Vain. Ann. Acad. Sci. Fenn. 15A, no. 6:207. 1921. Type: Guam, *MacGregor* 607 (US, isotype).

Graphis orientalis Vain. Ann. Acad. Sci. Fenn. 15A, no. 6:206. 1921. Type: Philippines, Merrill 6716 (isosyntype, US).

Graphina orientalis (Vain.) Zahlbr. Cat. Lich. Univ. 2:416. 1923.

Graphina macgregorii (Vain.) Zahlbr. Cat. Lich. Univ. 2:413. 1923.

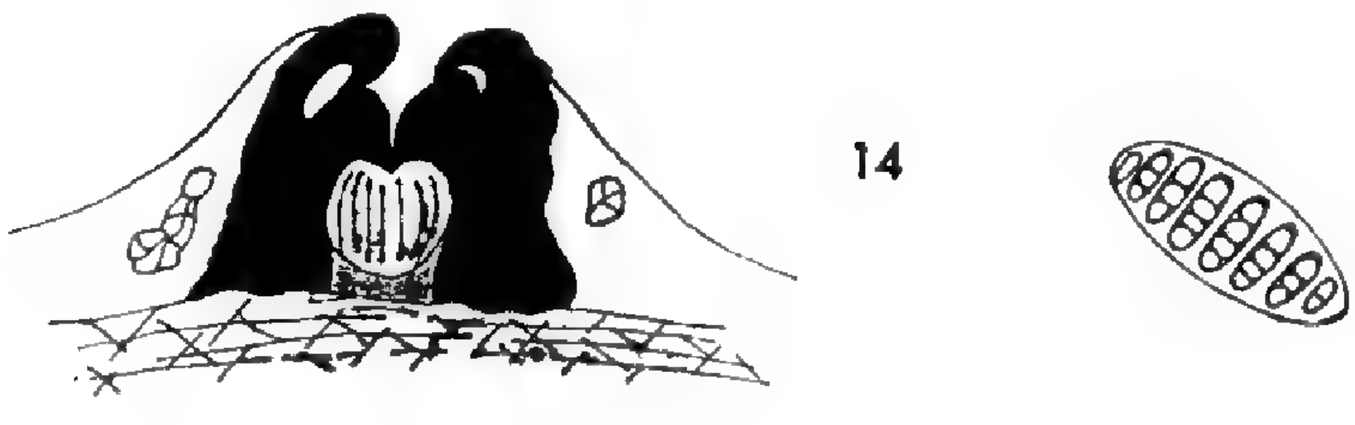
Thallus smooth, granular, or warty, continuous. Ascocarps unbranched, lightly flexuose, semiemergent or subsessile, 0.5–2 mm. long, about 0.5 mm. wide, black above, with a more or less prominent lateral thalline margin; exciple black, open; labia more or less convergent, entire; hymenium 100–200 μ high. Spores one per ascus, occasionally faint brown, 13–16×1–8 locular, 18–32×70–115 μ.

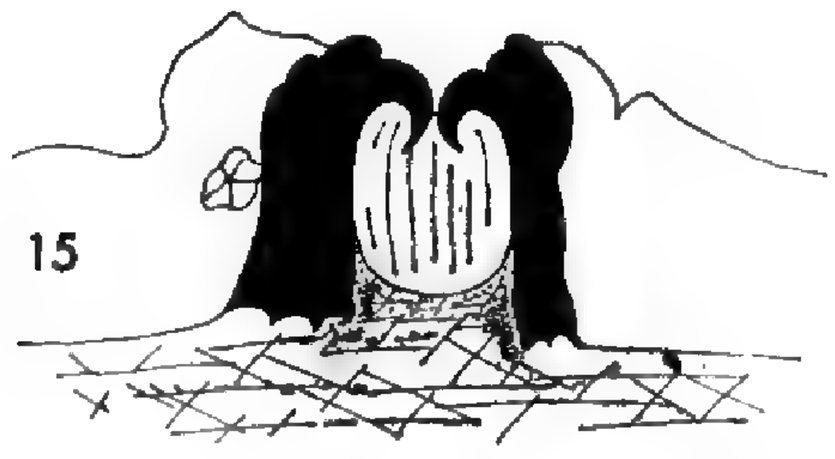
Reactions: KOH+ red, nostictic acid.

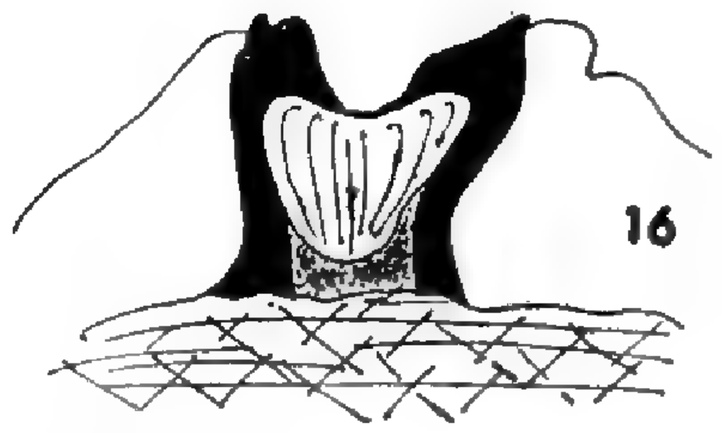
Specimens examined: Tamaulipas: Tampico, *Pringle* 5454, 5457 (MICH).

Fée published the name *Opegrapha endochroma* in 1824. Later, in his Supplement, he renamed the same entity *O. hiascens*, supposedly on the basis of better material. Müller, in transferring it to *Graphina*, chose to use the later epithet *hiascens* and listed *O. endochroma* as a synonym. Although *endochroma* has nomenclatural priority, the new combination should not be made until the materials in Fée's collections have been thoroughly examined.

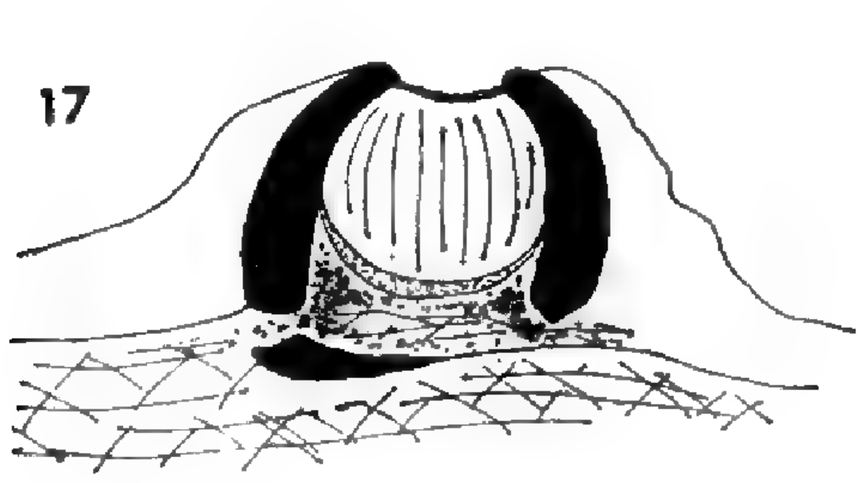
An isosyntype of *Graphis orientalis* (US) differs from typical *Graphina hiascens* only in having totally immersed ascocarps. In our opinion this is insufficient grounds for maintaining this entity as a

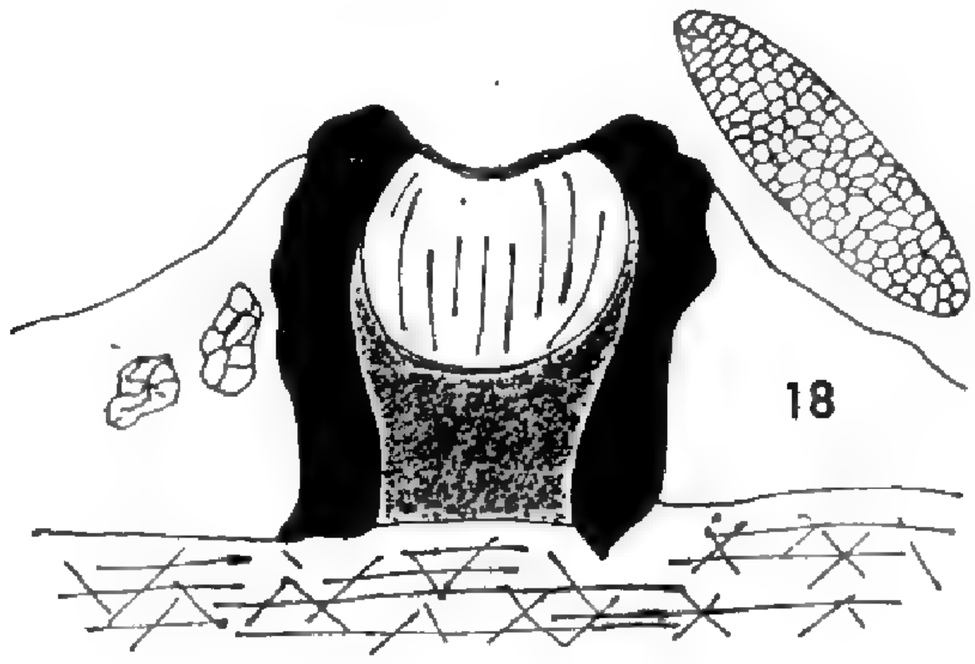


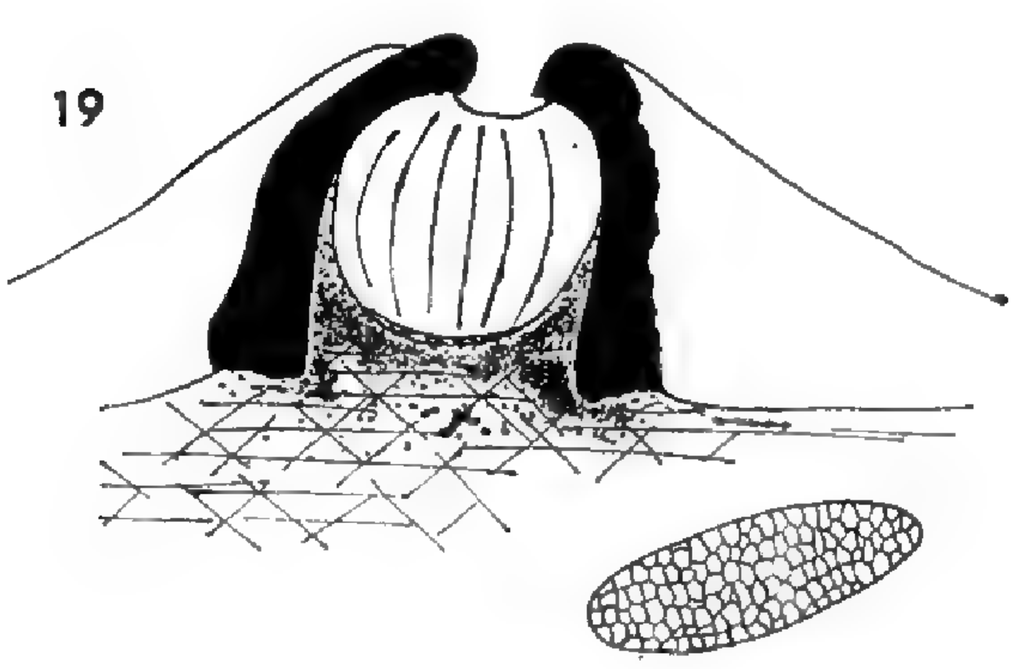


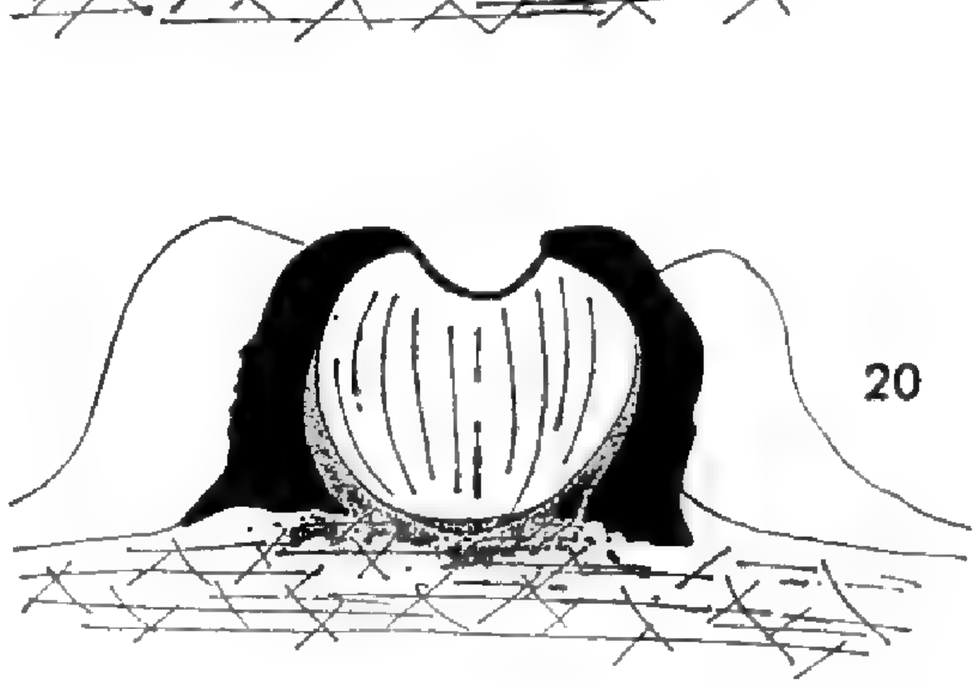


FIGURES 14–16.—**14.** *Graphina elongata* (Vain.) Zahlbr. (holotype, *Vainio* 782). 15–16. *G. elongatoradians* Fink (holotype, *Fink* 2049).









FIGURES 17–20.—17. *Graphina subserpentina* (Nyl.) Müll. Arg. (isotype, *Gardner* s.n.). 18. *G. macgregorii* (Vain.) Zahlb. (isotype, *MacGregor* 607). 19. *G. orientalis* (Vain.) Zahlbr. (isosyntype, *Merrill* 6716). 20. *G. hiascens* var. *clausior* (Vain.) Zahlbr. (isotype, *Ramos & Edano* 29548).

distinct species, since the degree of immersion is highly variable in this species. Isotypes of *G. macgregorii* and *G. subserpentina* differ from *G. hiascens* only in minor intergrading characters. An isotype of *G. hiascens* var. *clausior* (Vain.) Zahlbr. (US) from the Philippines is distinct in having elongate intricate ascocarps (fig. 20) and in producing stictic acid only.

7. Graphina hololeucoides (Nyl.) Müll. Arg. Flora 65:397. 1882.

FIGURE 21

Graphis hololeucoides Nyl. Ann. Sci. Nat. Bot. ser. 4, 20:266. 1863. Type: Mexico, *Ghiesbreght* (H, isotype).

Thallus uneven, often discontinuous. Ascocarps sessile or subsessile, lighter than the thallus, slightly mealy, unbranched, round to elliptical, 0.5–0.8 mm. wide, 1–1.5 mm. long; exciple barely closed, colorless below; labia internally irregularly striate, slightly darkened; hymenium about 100 μ high. Spores 4–6 per ascus, 20–30×1–4 locular, 15–18×60–100 μ.

Reactions: Thallus KOH—, P—; ascocarps KOH+ faint, P+ red. No microchemical tests made.

Although the isotype is too small to extract, the color reactions suggest the presence of protocetraric acid.

8. Graphina insignis (Vain.) Zahlbr. Cat. Lich. Univ. 2:410. 1923.

FIGURES 22, 23

Graphis insignis Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:112. 1890. Lectotype: Carassa, Minas Gerais, Brazil, *Vainio* 1209 (TUR).

Graphina insignis var. *primaria* Redgr. Ark. Bot. 26A, no. 1:21. 1933. Syntypes: Brazil, *Malme* 2299, 3509 p.p. (S).

Graphina insignis var. *imperfecta* Redgr. Ark. Bot. 26A, no. 1:21. 1933. Holotype: Brazil, *Malme* 3514 (S). Reactions: KOH+ red, P—, gummy residue, atranorine only.

Graphina insignis var. *tartarea* Redgr. Ark. Bot. 26A, no. 1:22. 1933. Syntypes: Brazil, *Malme* 2549, 3509 p.p. (S).

Thallus thick, nitid, continuous or fissured, usually carbonized near the substrate, often with soredia-like eruptions. Ascocarps immersed, usually bordered by a lighter area of thallus, irregular, flexuose, simple to asteroidly branched, often anastomosing into large contorted fertile areas, 1–5 mm. long, up to 1 mm. wide; disc plane or depressed, caesiopruinose; exciple closed, pale to dark brown, sometimes carbonized at the very base; labia divergent, entire; hymenium 100–175 μ high, epithecium prominent. Spores 8 per ascus, ovoid, 4–5×1–3 locular, 5–8×10–15 μ.

Reactions: KOH+ red, P—, o-T—, gummy residue, no acids demonstrated.

Specimen examined: Chiapas: Lagos de Monte Bello, *Hale* 20449 (DUKE, REN, S, TNS, US).

Graphina insignis was placed by Redinger in the section *Platygraphopsis*. However, examination of the Vainio syntypes and Redinger's types showed that the exciples are usually uncarbonized or only rarely carbonized at the base. The thick band of black tissue which separates the thallus from the substrate is quite variable, and it seems superfluous to name each variation.

This species is apparently restricted to substrata of decaying organic matter, such as rotten wood, old twigs, grass, and detritus on

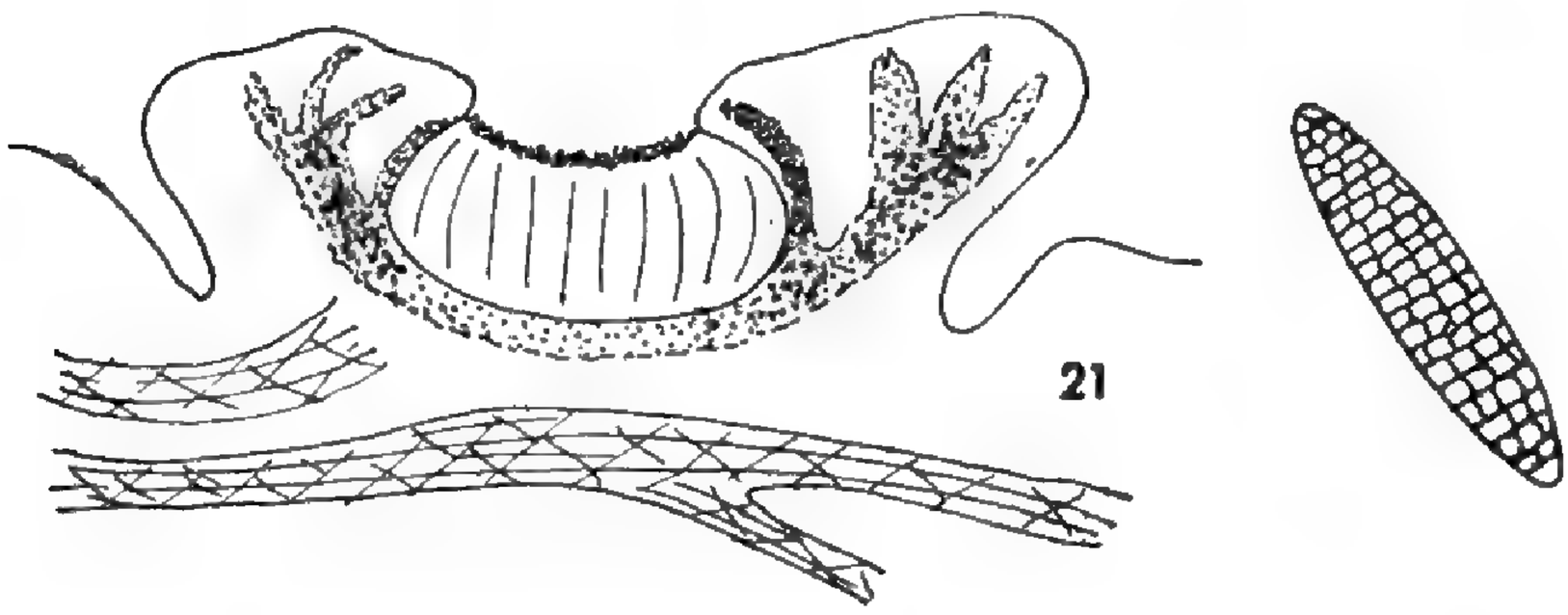
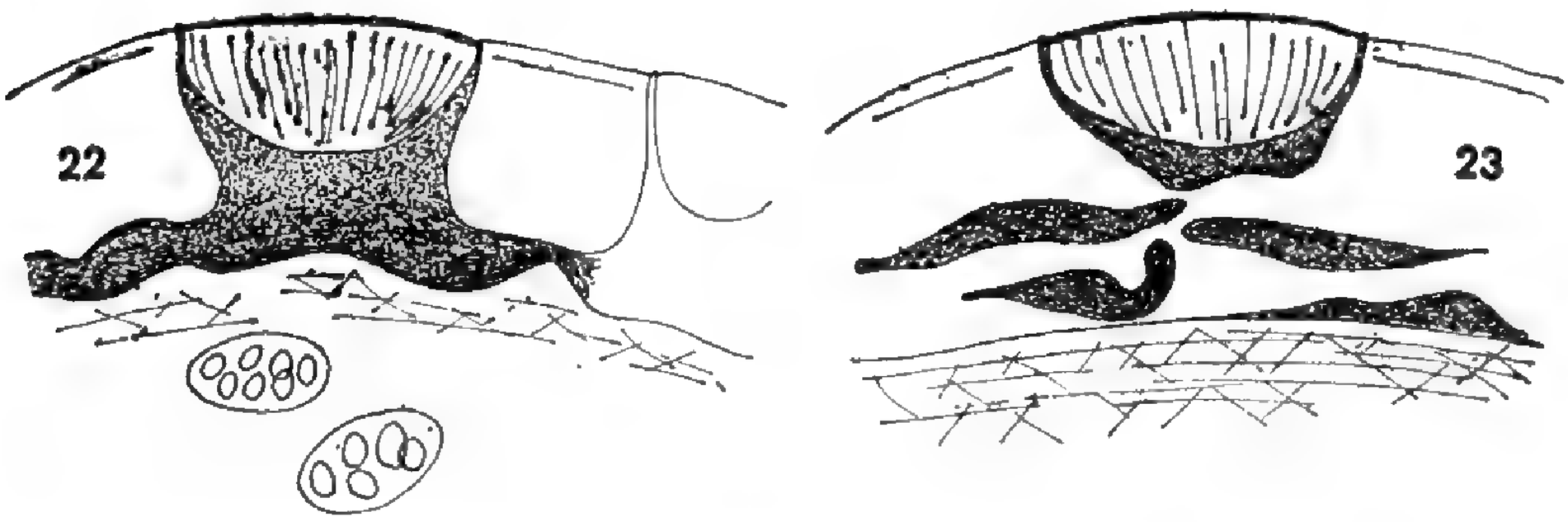


FIGURE 21.—*Graphina hololeucoides* (Nyl.) Müll. Arg. (isotype, *Ghiesbreght* s.n.).



FIGURES 22–23.—22. *Graphina insignis* (Vain.) Zahlbr. (lectotype, *Vainio* 1209). 23. *G. insignis* (*Hale* 20449).

rocks. It forms a heavy thallus with characteristic soredia-like outgrowths and frequently fused ascocarps. It must have a very rapid growth rate to be able to colonize such unstable habitats.

All of the specimens react KOH+ red and yield from acetone a clear gummy residue which is unrecrystallizable. Only one specimen (the holotype of var. *imperfecta*) yielded atranorine.

9. Graphina inturgescens (Kremplh.) Müll. Arg. Flora 71:545. 1888.

FIGURES 24–27

Graphis inturgescens Kremplh. Flora 59:383. 1876. Holotype: Brazil, *Glaziou* 6286 (M).

Graphis phaeospora Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:97. 1890. Holotype: Sitio, Minas Gerais, Brazil, *Vainio* 682 (TUR).

Graphina acharii var. *subintegra* Zahlbr. Ann. Mycol. 19:230. 1921. Types: Tampico, Tamaulipas, Mexico, *Pringle* 5 p.p., 25 p.p. (MICH, isosyntypes).

Phaeographina phaeospora (Vain.) Zahlbr. Cat. Lich. Univ. 2:443. 1923.

Thallus continuous, thick, somewhat roughened, saxicolous or corticolous. Ascocarps sessile, flexuose, elongate, rarely branched, to 6 mm. long, covered up to or nearly to the apex by a thalline margin; exciple black, closed; labia convergent, entire or crenate; hymenium 150–300 μ high. Spores 2–4 (–6?) per ascus, colorless or nearly so, 17–30×1–5 locular, 15–30×80–160 μ.

Reactions: KOH+ reddish, P—, no acids demonstrated.

We have been unable to find any differences between the various species listed above other than the fact that the holotype of *G. inturgescens* is saxicolous while the others are corticolous. The spores in all three types are colorless or rarely pale brown, Vainio's name *phaeospora* notwithstanding! The labia vary from entire to crenate and are covered by a thin to thick thalline veil.

It is altogether likely that *G. inturgescens* is referable to the polymorphic *G. acharii*. *Graphina inturgescens* can be provisionally separated by the subentire rather than distinctly striate labia.

10. Graphina macella (Kremplh.) Müll. Arg. Flora 63:23. 1880. FIGURE 28
Graphis macella Kremplh. Flora 59:380. 1876. Holotype: Brazil, *Glaziou* 6289b (M).

Thallus continuous, smooth. Ascocarps semiemergent to subsessile, stout, sparingly branched, straight to flexuose, black above, white striped, 1–5 mm. long, about 0.5 mm. wide; exciple black, closed; labia convergent, 1–4 sulcate; hymenium 150–200 μ high. Spores one per ascus, 25–35×3–12 locular, 20–40×65–130 μ.

Reactions: KOH+ yellow, P—, 0-T—, G.E.—, no acids demonstrated.

Specimen examined: Chiapas: Southeast of San Cristóbal, *Hale* 20275 (US).

Graphina macella is closely related to *G. acharii*, from which it differs in having only one rather rotund spore per ascus. The Mexican material differs from the holotype of *G. macella* in having fewer striae, and the exciple is peculiarly infuscated below. There is little doubt however as to the identity of the two specimens.

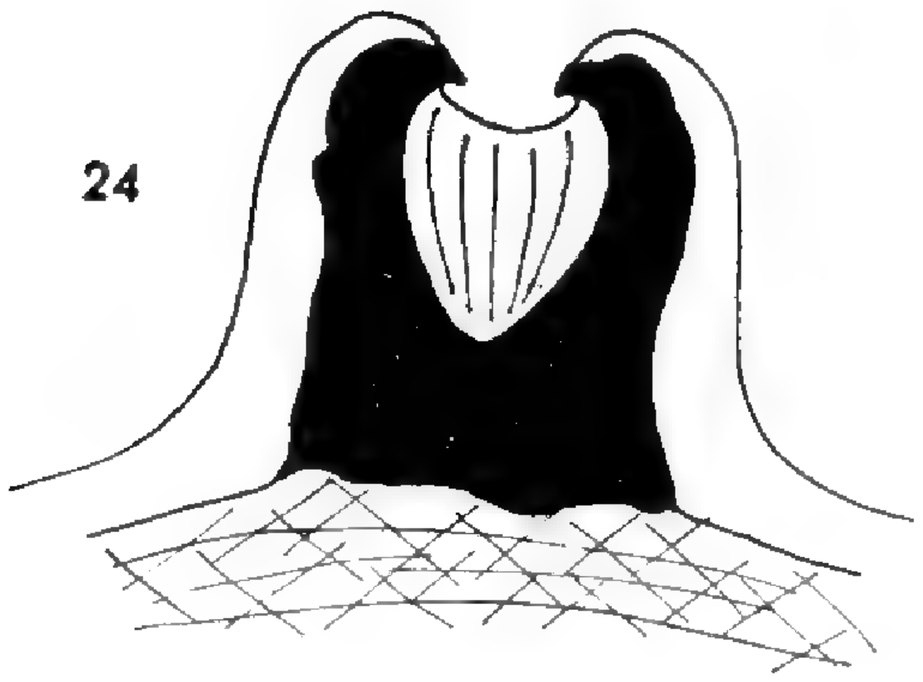
11. Graphina mexicana (Zahlbr.) comb. nov. FIGURE 29
Enterodictyon mexicanum Zahlbr. Ann. Mycol. 19:233. 1921. Holotype: Cuernavaca, Mexico, *Pringle* 20 (W).

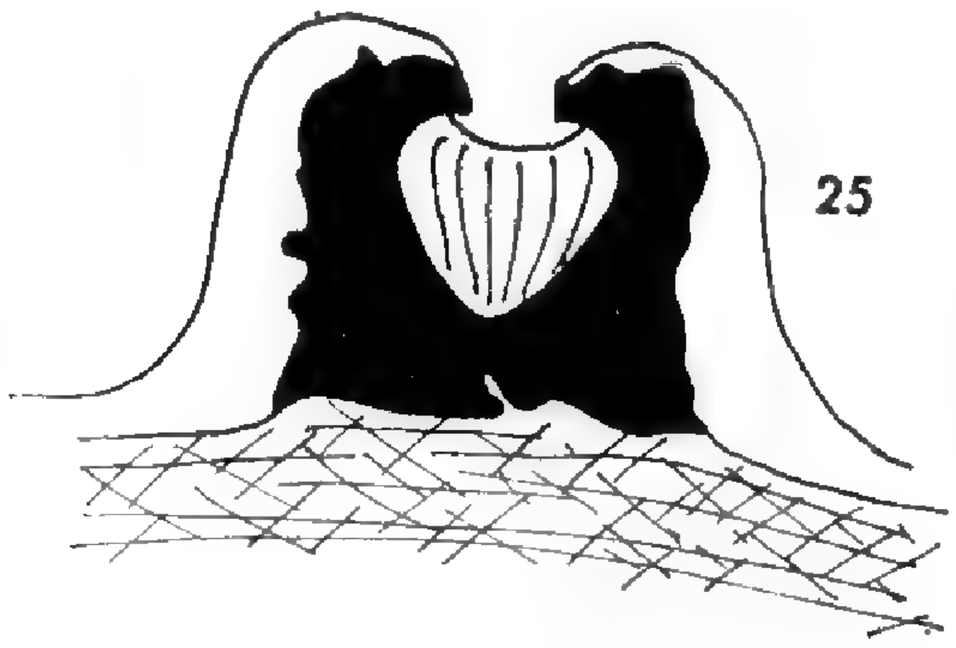
Thallus smooth to minutely roughened, continuous. Ascocarps in densely intricated clusters, appearing as gaping, very light-colored fissures; exciple colorless or rudimentary, barely closed to open; labia convergent at first, then somewhat spreading, composed at least partially of bark cells; hymenium about 90 μ high. Spores 6–8 per ascus, occasionally halonate, 4–5×1–3 locular, 8–13×23–40 μ.

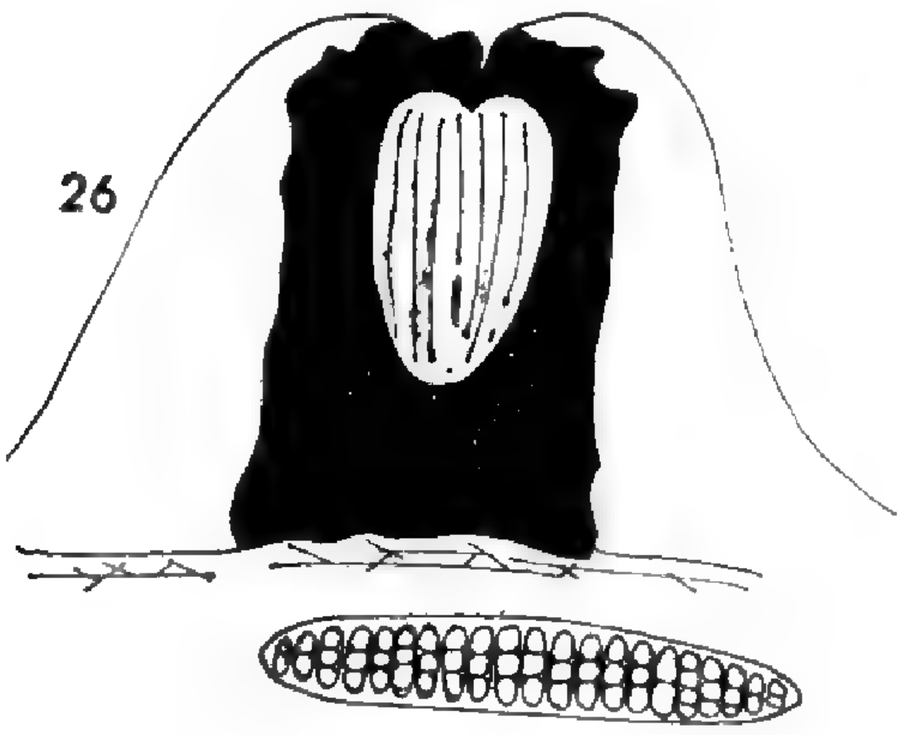
Reactions: KOH+ red, P—, o-T—, no acids demonstrated.

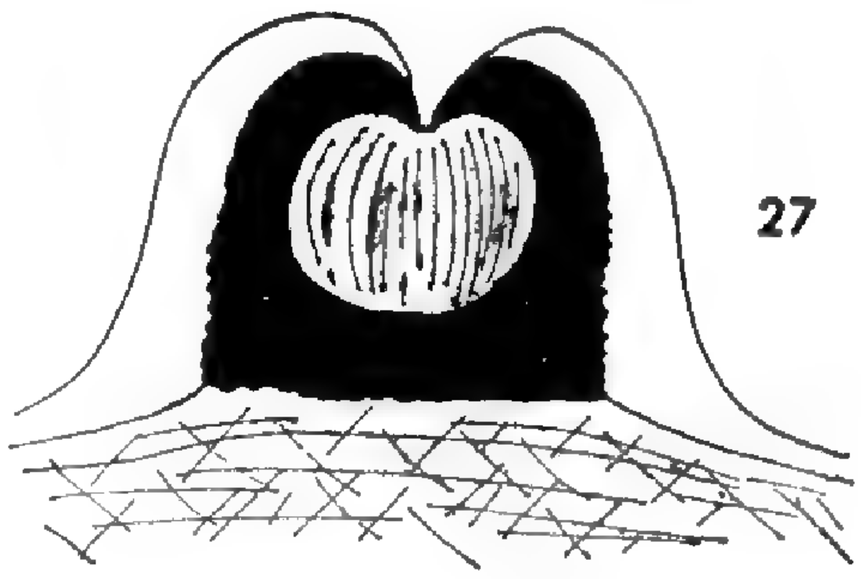
Specimen examined: San Luis Potosí: Las Palmas, *Pringle* 225 (FH, VT).

The holotype of *Enterodictyon mexicanum* is obviously referable to *Graphina*. *Pringle* 225 was determined by Müller (1894, p. 92) as *Medusulina nitida* (Eschw. in Mart.) Müll. Arg., but we could find no trace of anything resembling stromatoid tissue in the specimen. Since the type of *M. nitida* has not been available for comparison and









FIGURES 24–27.—24–25. *Graphina inturgescens* (Kremplh.) Müll. Arg. (holotype, *Glaziou* 6286). 26–27. *Phaeographina phaeospora* (Vain.) Zahlbr. (holotype, *Vainio* 682).

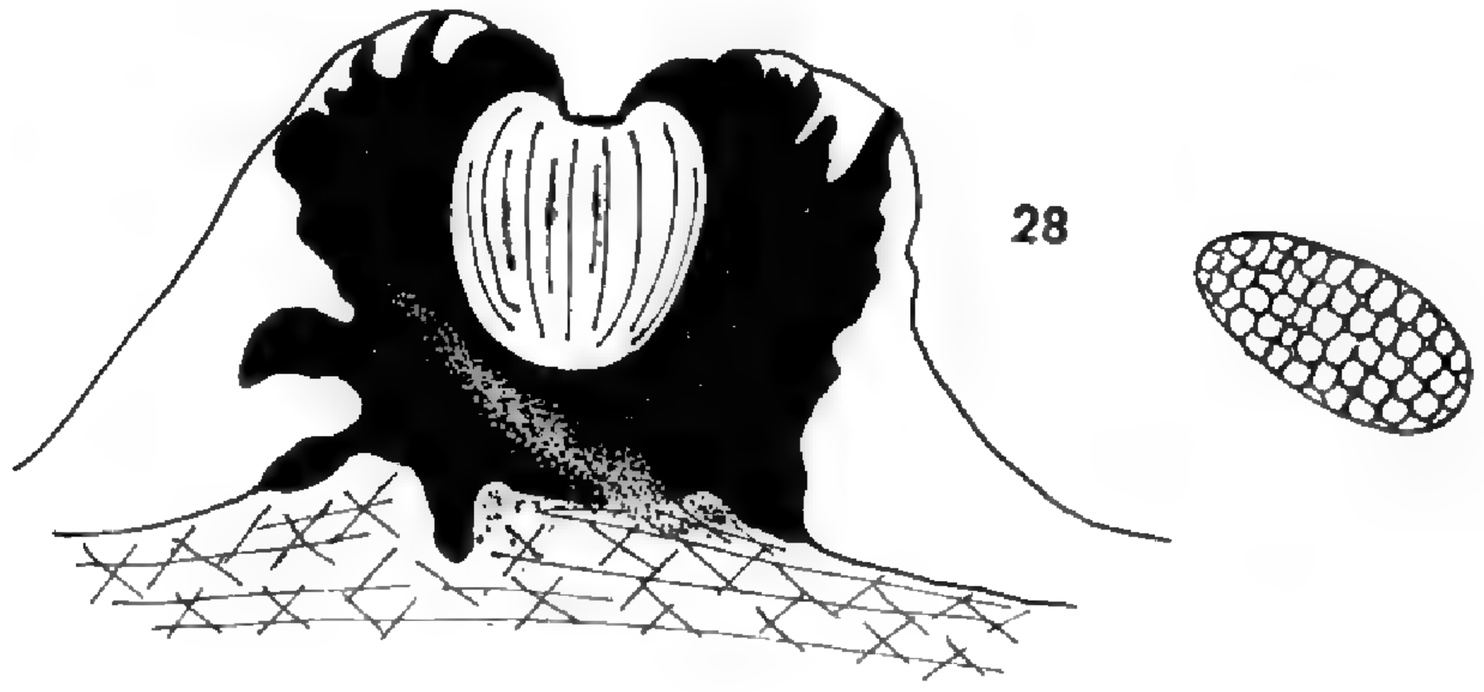


FIGURE 28.—*Graphina macella* (Kremplh.) Müll. Arg. (holotype, *Glaziou* 6289b).

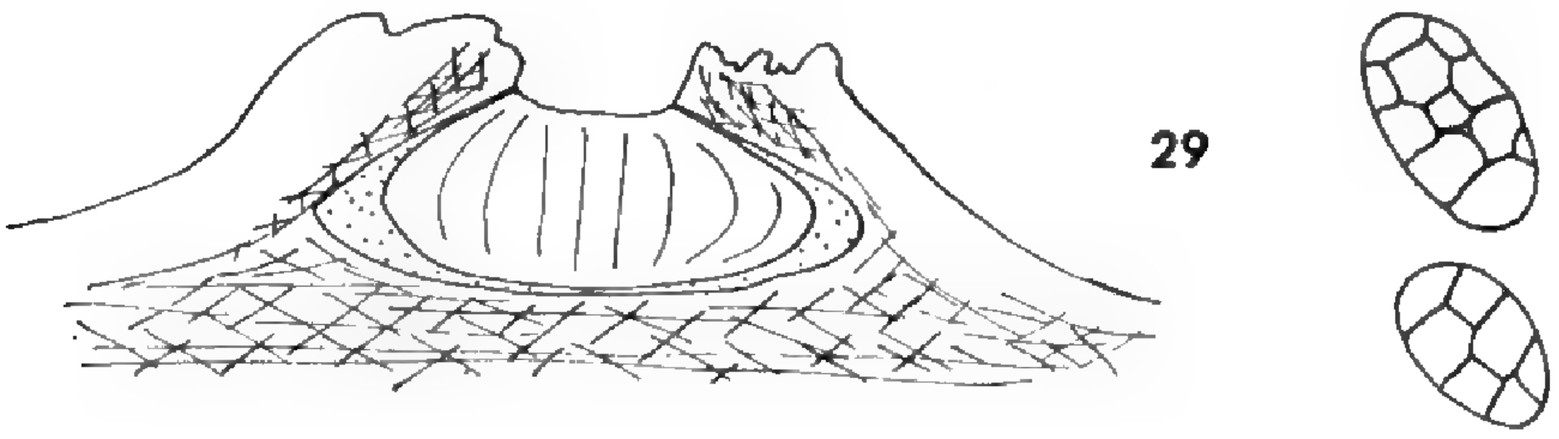


FIGURE 29.—*Graphina mexicana* (Zahlbr.) Wirth & Hale (holotype, *Pringle* 20).

is probably lost, it is best to transfer *Enterodictyon mexicanum* to *Graphina*, even though it may eventually be proved to be a synonym of *Graphina nitida* (Eschw. in Mart.) Müll. Arg.

12. Graphina palmeri Zahlbr. Ann. Mycol. 19:231. 1921. FIGURE 30

Type: Cuernavaca, Morelos, Mexico, *Pringle* 9 (MICH, isotype).

Thallus much fissured and irregular. Ascocarps small, more or less immersed to semiemergent, 0.5–1.5 mm. long, slender, concolorous with the thallus; exciple closed, brown laterally, colorless below the hymenium; labia sulcate, with brown inclusions, covered by a thick thalline margin. Spores 8 per ascus, 12–15×3–6 locular, 15–18×45–75 μ.

Reactions: KOH+ red, unknown acid in G.A. o-T.

The unknown acid in the type is identical with that found in *Graphina triangularis*, *G. virginea*, and *Phaeographis exaltata*. In G.A. o-T. the crystals are somewhat similar to those of barbatic acid.

13. Graphina parilis (Krempl h.) Müll. Arg. Bull. Soc. Bot. Belg. 32:152. 1892. FIGURES 31–35

Graphis parilis Krempl h. Flora 59:422. 1876. Holotype: Brazil, *Glaziou* 3394 (M). Reactions: KOH+yellowish, no chemical tests made.

Graphis annulata Krempl h. Flora 59: 445. 1876. Holotype: Brazil, *Glaziou* 3388 (M). Reactions: KOH+ yellowish, no chemical tests made.

Graphina acromelaena Müll. Arg. Bull. Soc. Bot. Belg. 32:152. 1893. Holotype: San José, Costa Rica, *Tonduz* (G).

Graphina achrophaea Müll. Arg. Bull. Herb. Boiss. 3:46. 1895. Type: Louisiana, *Langlois* 751 (US, isotype).

Graphis subducta Vain. Ann. Acad. Sci. Fenn. 15A, no. 6:203. 1921. Type: Luzon, Philippines, *Merrill* 8576 (US, isotype).

Graphina pringlei Zahlbr. Ann. Mycol. 19:230. 1921. Type: Tampico, Tamaulipas, Mexico, *Pringle* 11 (not seen).

Graphina subducta (Vain.) Zahlbr. Cat. Lich. Univ. 2:426. 1923.

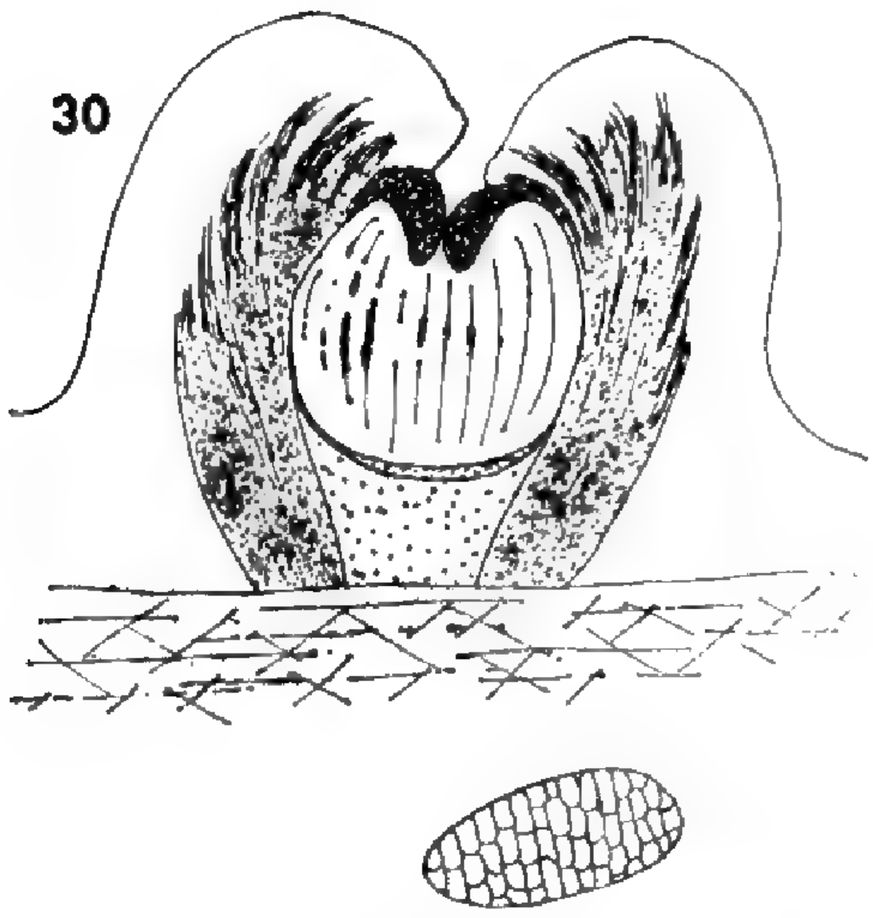
Graphina acrophaea f. *multilamellosa* Redgr. Ark. Bot. 26A, no. 1:52. 1933, Holotype: Colonia Risso, Paraguay, *Malme* 3545 (S).

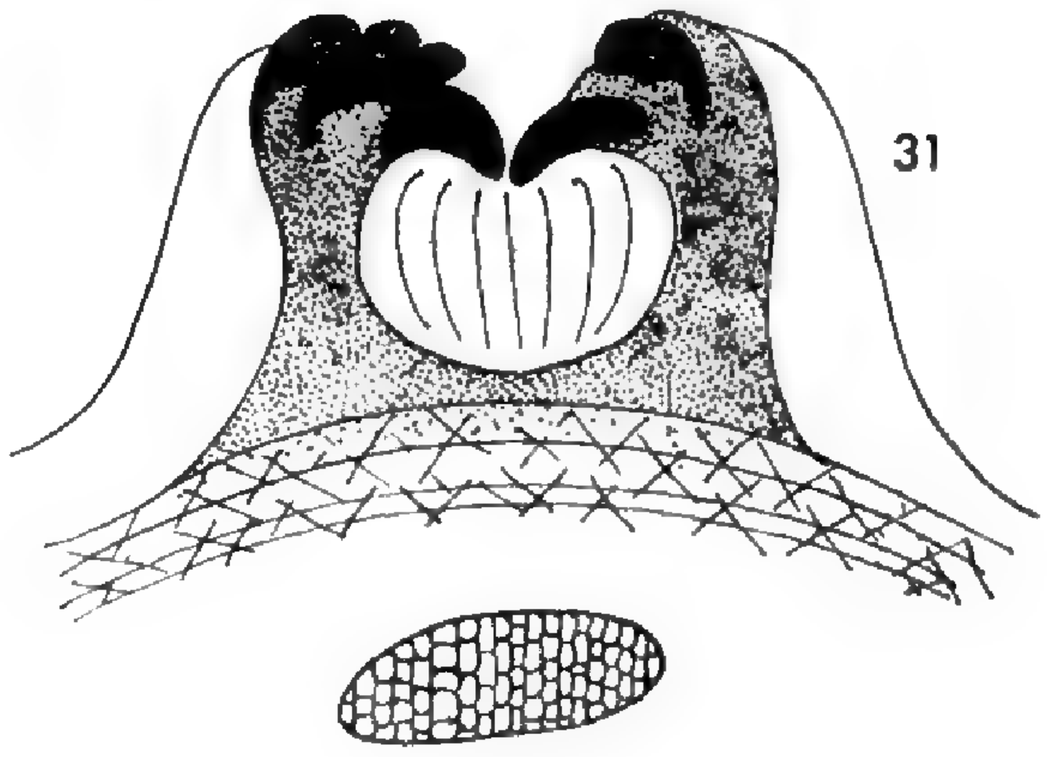
Graphina puiggarii f. *corumbensis* Redgr. Ark. Bot. 26A, no. 1:56. 1933. Syntypes: Matto Grosso, Brazil, *Malme* 3631, 3638 (S).

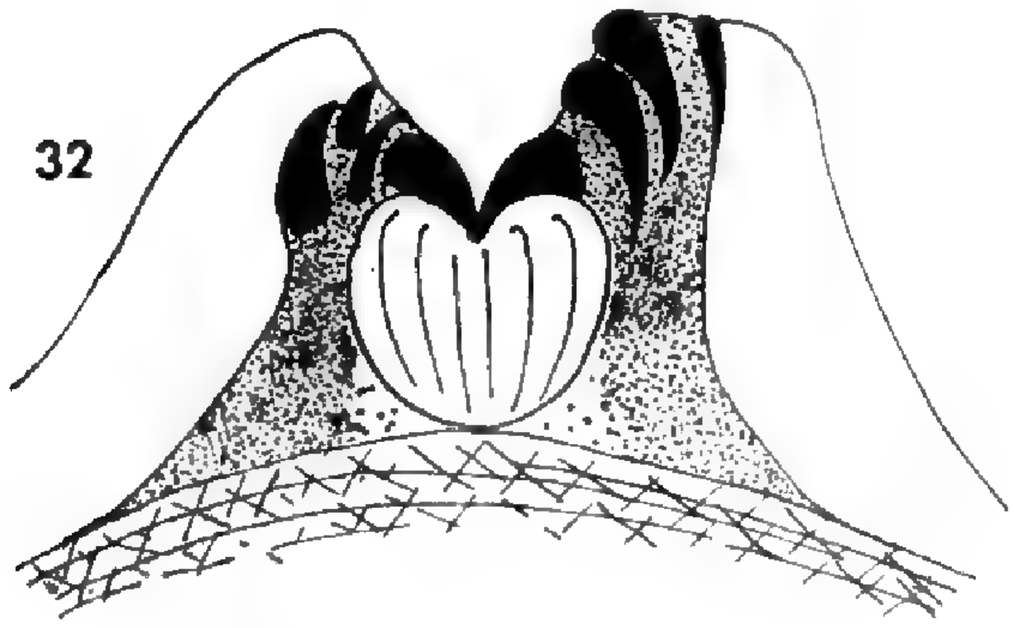
Thallus continuous, smooth to minutely roughened. Ascocarps dispersed to clustered, semiemergent to subsessile, unbranched to 3–4 branched, lightly flexuose to curved and intricate, black above, often with a raised thalline margin, 1–5 mm. long, 0.3–0.6 mm. wide; exciple black above, yellow or pale brown below, closed or open; labia convergent, 4–10 striate, often barely so in some portions of the ascocarps. Spores 8 per ascus, occasionally halonate, 12–20×1–7 locular, 10–20×28–80 μ.

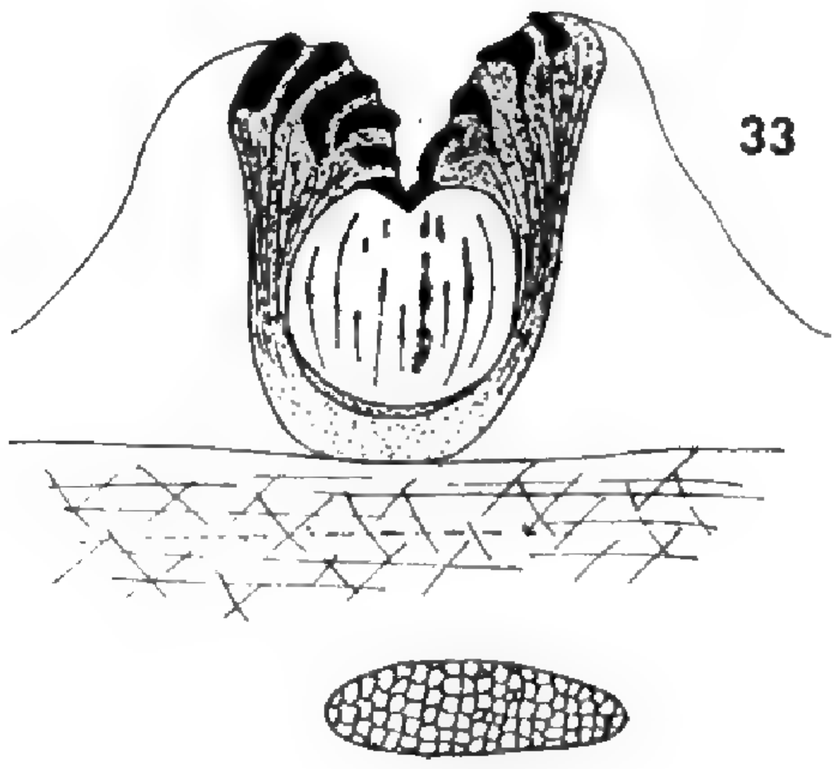
Reactions: KOH+ yellow, stictic acid (accompanied by atranorine only in the holotype of *Graphina acrophaea* f. *multilamellosa* Redgr. and in *Hale* 21145 and *Pringle* 160 p.p.).

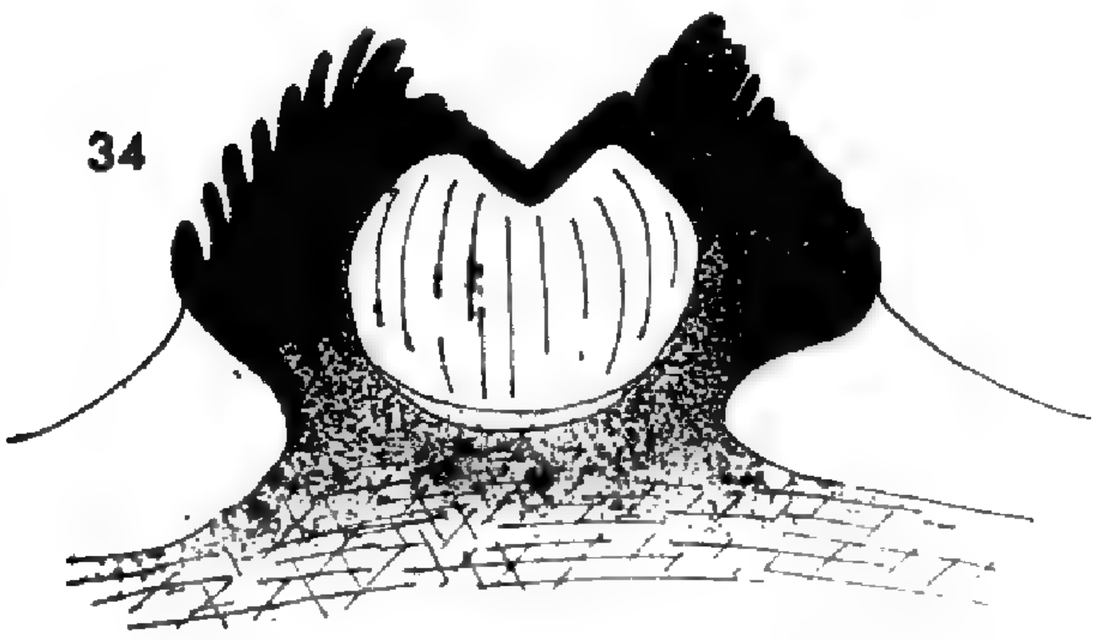
Specimens examined: San Luis Potosí: Tamasopo, *Pringle* 160 p.p. (VT). Vera Cruz: South of Xico near Teocello canyon, *Hale* 21145, south of Catemaco, *Hale* 21085, northeast of Huatusco, *Hale* 19491 (US).

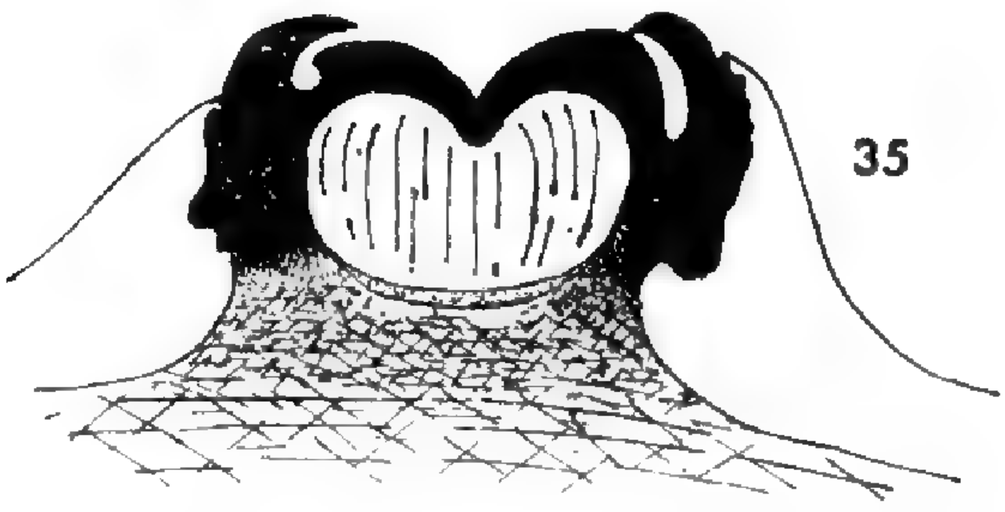












FIGURES 30–35.—30. *Graphina palmeri* Zahlbr. (holotype, *Pringle* 9). 31. *G. parilis* (Krempelh.) Müll. Arg. (holotype, *Glaziou* 3394). 32. *Graphis annulata* Kremplh. (holotype, *Glaziou* 3388). 33. *Graphina acrophaea* Müll. Arg. (isotype, *Langlois* 751). 34. *G. acrophaea* f. *multilamellosa* Redgr. (holotype, *Malme* 3545). 35. *G. puiggarii* f. *corumbensis* Redgr. (syntype, *Malme* 3636).

Examination of the seven types listed above in synonymy disclosed that these individuals are parts of a single variable species. Separating them on the basis of open or closed exciples is difficult, since this character is not constant and intergrading forms are common. Spore size and septation are very similar, considering that these characters normally vary greatly even within a single ascocarp. The number of striae in the labia is apparently related to the age of the specimen, and therefore a name such as *Graphina acrophaea* f. *multilamellosa* is unnecessary.

The type of *Graphina pringlei* Zahlbr. is not at Vienna and may have been lost in World War II. It seems most likely that it is a synonym of *G. parilis*, at least on the basis of the original description and on that of Redinger (1933, p. 50) who last borrowed the specimen. Zahlbruckner cited KOH— as a reaction, but this is not unusual because stictic acid is sometimes so scarce that color tests (though not microchemical tests) are negative.

Although *Graphina puiggarii* var. *corumbensis* Redgr. is referable to *G. parilis*, the holotype of *G. puiggarii* var. *puiggarii* Müll. Arg. (*Puiggari* 506, G) is not. *G. puiggarii* has a completely black, almost closed exciple of different construction from that found in *G. parilis*.

The type of *G. acromelaena* was given by Müller as *Pittier* 6167, but the holotype is labeled Tonduz. According to Dr. C. E. B. Bonner (in litt.), "Types which were published with Pittier numbers appear to have been collected by Tonduz and numbered after Müller had studied the material."

14. Graphina peplophora sp. nov. FIGURE 36

Thallus corticola, continuus, laevis, 70–80 μ crassus, strato corticale plus minusve cellulare, 20–25 μ crasso. Apothecia dispersa, emergentia vel subsessilia, simplicia, raro furcata, recta vel undulata, 1–5 mm. longa, 0.5–1 mm. lata, superne albofarinosa, quam thallo pallidiore, excipulo dimidiato, rufescente, labiis convergentibus, in 5–6 striis clavatis divisis; hymenium ellipticum vel rotundatum, 125–250 μ altum. Sporae decolores vel leviter fuscescentes, 35–78 μ longae, 18–36 μ latae, loculis horizontalibus 10–16, loculis transversis 5–8.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.

Type in the U.S. National Herbarium, collected at Tampico, Mexico, July 1896, by C. G. Pringle, no. 408 (isotype in MICH).

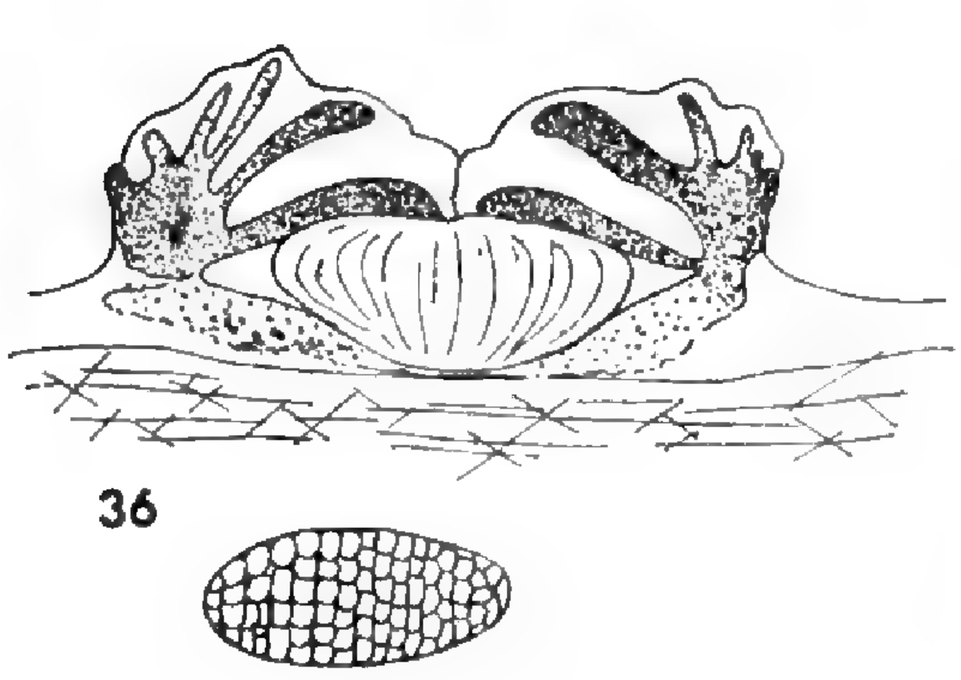
Specimens examined: Mexico. Tamaulipas: Tampico, *Pringle* 15460 (FH, MICH). Cuba. *Wright* 5, 425, 426 (US). Bonin Islands, *Wright* (US).

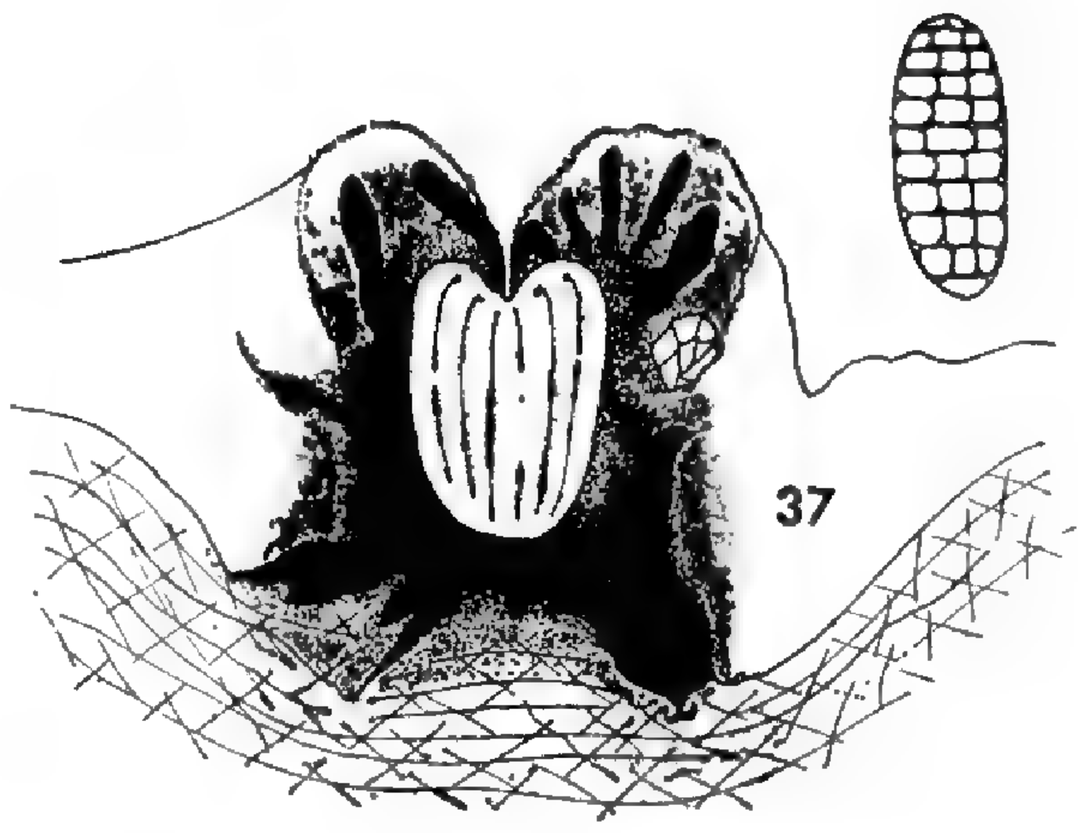
Nylander published this species as a nomen nudum under *Graphis leucocarpa* in Flora 69:103, 1886. On the basis of specimens examined so far, it is difficult to decide whether this entity should be placed in *Graphina* or *Phaeographina*. The spores vary from completely hyaline to pale brown. Its affinities lie structurally with *Graphina*, particularly with *G. corcovadensis* Redgr. which differs in having one spored asci, ascocarps and thallus concolorous, and exciples closed.

15. Graphina rimulosa Redgr. Ark. Bot. 26A, no. 1:39. 1933. FIGURE 37

Holotype: Rio Grande do Sul, Brazil, *Malme* 1089 (S).

Thallus smooth, continuous, rather irregular. Ascocarps emergent, flexuose and irregular, rarely branched, 2–4 mm. long, about 0.4 mm.





FIGURES 36–37.—36. *Graphina peplophora* Wirth & Hale (holotype, *Pringle* 408). 37. *G. rimulosa* Redgr. (holotype, *Malme* 1089).

wide, generally somewhat clumped in elevated groups, each ascocarp surrounded and partially covered by a whitish thalline border; exciple closed, very irregular, partially carbonized, partially dark brown; labia irregularly striate or disintegrated, partially covered with a loose thalline veil; hymenium 120–140 μ high. Spores 6–8 per ascus, 10–13×1–4 locular, 10–15×30–45 μ.

Reactions: KOH+ reddish, no microchemical tests made.

Specimen examined. Hidalgo: Honey Station, *Pringle* 10863 p.p. (VT).

The Pringle collection is nearly identical with the Brazilian holotype. Both show the peculiar whitish lateral covering over the ascocarps and the highly irregular exciple, features which characterize this species.

16. Graphina scolecitis (Tuck.) Fink, Lich. Flora U.S. 115. 1935. FIGURE 38

Graphis scolecitis Tuck. Gen. Lich. 210. 1872. Type: Alabama, U.S.A., *Beaumont* (US, isotype).

Graphina cinerea Fink, Mycologia 19:216. 1927. Holotype: Mayagüez, Puerto Rico, *Fink* 1163 (MICH).

Graphina olivobrunnea Fink, Mycologia 19:216. 1927. Holotype: Mayagüez, Puerto Rico, *Fink* 1224 (MICH).

Thallus smooth to minutely roughened, continuous. Ascocarps emergent to subsessile, usually darker than the thallus but occasionally concolorous, slender, unbranched to 2–3 branched, 1–5 mm. long; exciple open to nearly closed, red-brown; labia entire, often loosely constructed apically; hymenium 50–120 μ high. Spores 8 per ascus, 4–8×1–3 locular, 5–10×13–29 μ.

Reaction: Thallus KOH−, P−; ascocarps KOH+ dark purple, no microchemical tests made.

Specimen examined. San Luis Potosí: Las Palmas, *Pringle* 233 (FH, H, US, VT).

Pringle 233 was identified as the New Caledonian *Graphina adscribens* (Nyl.) Müll. Arg. by Eckfeldt (1892, p. 252). However, we have not checked this type, and there is little reason to suppose that Eckfeldt made a correct determination. The specimens above are all referable to *G. scolecitis*, which was published four years later than *G. adscribens*. The two Fink species differ from typical *G. scolecitis* only in being somewhat smaller.

17. Graphina sulcata Fink, Mycologia 19:217. 1927. FIGURES 39, 40

Holotype: Río Piedras, Puerto Rico, *Fink* 659 (MICH).

Thallus smooth to minutely roughened, continuous. Ascocarps subsessile to semi-immersed, straight to flexuose, entire or sparingly branched, 1–5 mm. long, 0.2–0.5 mm. wide; exciple black above, yellow or brownish laterally, open or nearly closed below; labia 3–4 sulcate, convergent. Spores (2–)4–6 per ascus, 5–8×2–5 locular, 10–20×20–34 μ.

Reactions: KOH+ red, norstictic acid.

Specimens examined: Chiapas: El Suspiro, *Hale* 20233, 20068 (US).

Graphina sulcata differs from the very closely allied *G. parilis* in having 2–6, not 8, spores per ascus, constantly fewer locules per spore, and norstictic rather than stictic acid.

18. Graphina sulcatula Müll. Arg. var. **conglomerata** Müll. Arg. Rev. Mycol. 10:119. 1888. FIGURE 41

Syntypes: Paraguay, *Balansa* 4185a (G), 485 (not seen).

Thallus smooth, very thin. Ascocarps sessile, black, clustered in round or irregular clumps, 1–2 mm. in diameter; disc dark brown; exciple black, closed; labia convergent, entire to lightly crenate; hymenium 75–90 μ high. Spores 6–8 per ascus, 6–8×1–4 locular, 10–13×30–35 μ.

Reactions: KOH−, P−, o-T−, no acids demonstrated.

Specimens examined: Oaxaca: Northwest of Tehuantepec, *Hale* 20629 (US).

The ascocarps of this taxon form distinct isolated clumps which are elevated well above the thallus. They are heavily carbonized, rather brittle, and difficult to section properly.

19. Graphina triangularis Zahlbr. Ann. Mycol. 19:232. 1921. FIGURE 42

Type: Tampico, Tamaulipas, Mexico, *Pringle* 17 (MICH, isotype).

Thallus smooth, very thick, continuous or lightly fissured. Ascocarps more or less immersed, 1–2 branched, flexuose, slender, to 2 mm. long; exciple brown, closed, basally continuous in a carbonized band; labia lightly striate, slightly convergent; hymenium triangular, 280–300 μ high; epithecium brown, thick. Spores 4–8 per ascus, 12–15×5–7 locular, 15–25×45–75 μ.

Reactions: KOH+ red, unknown acid in G.A. o-T.

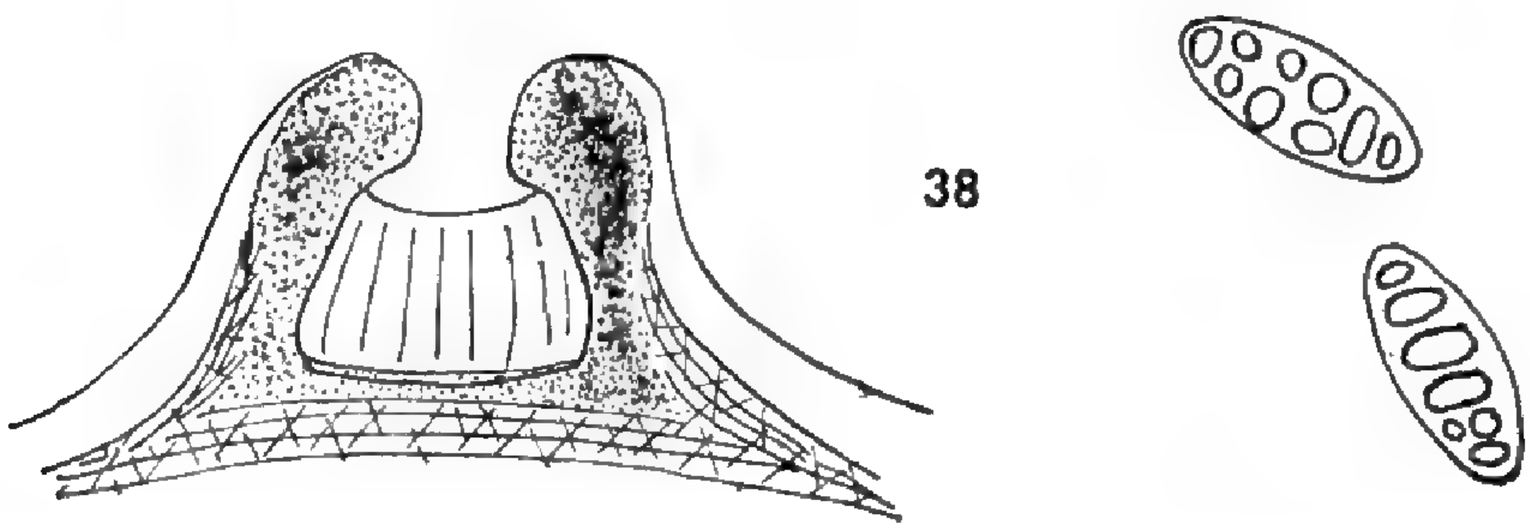
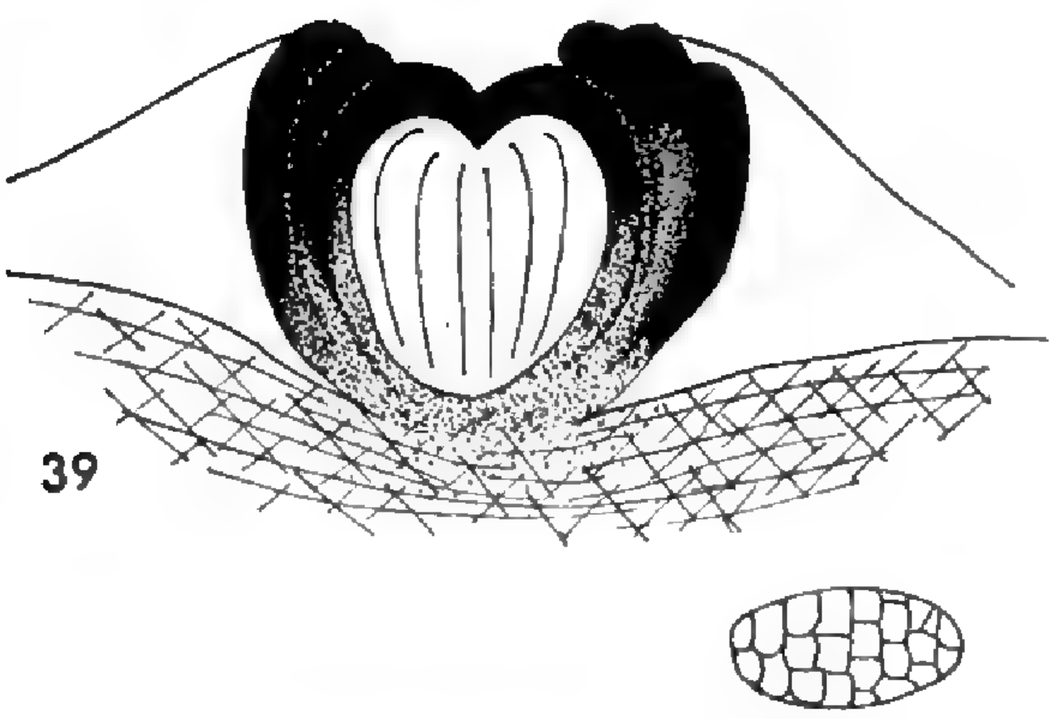
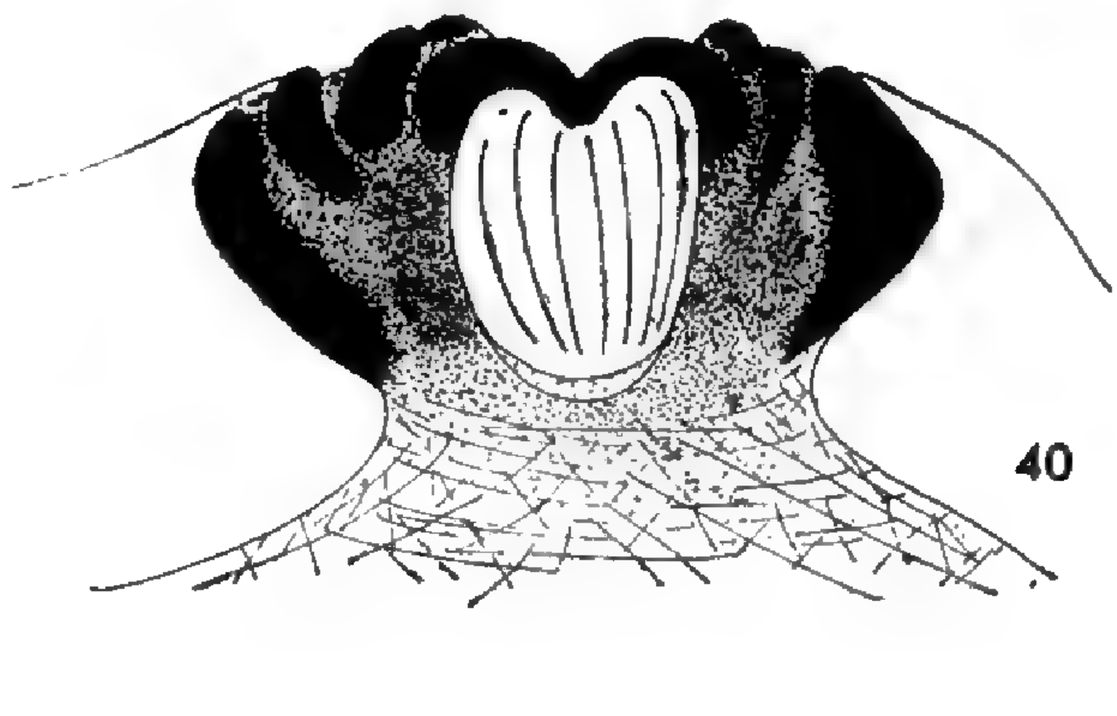
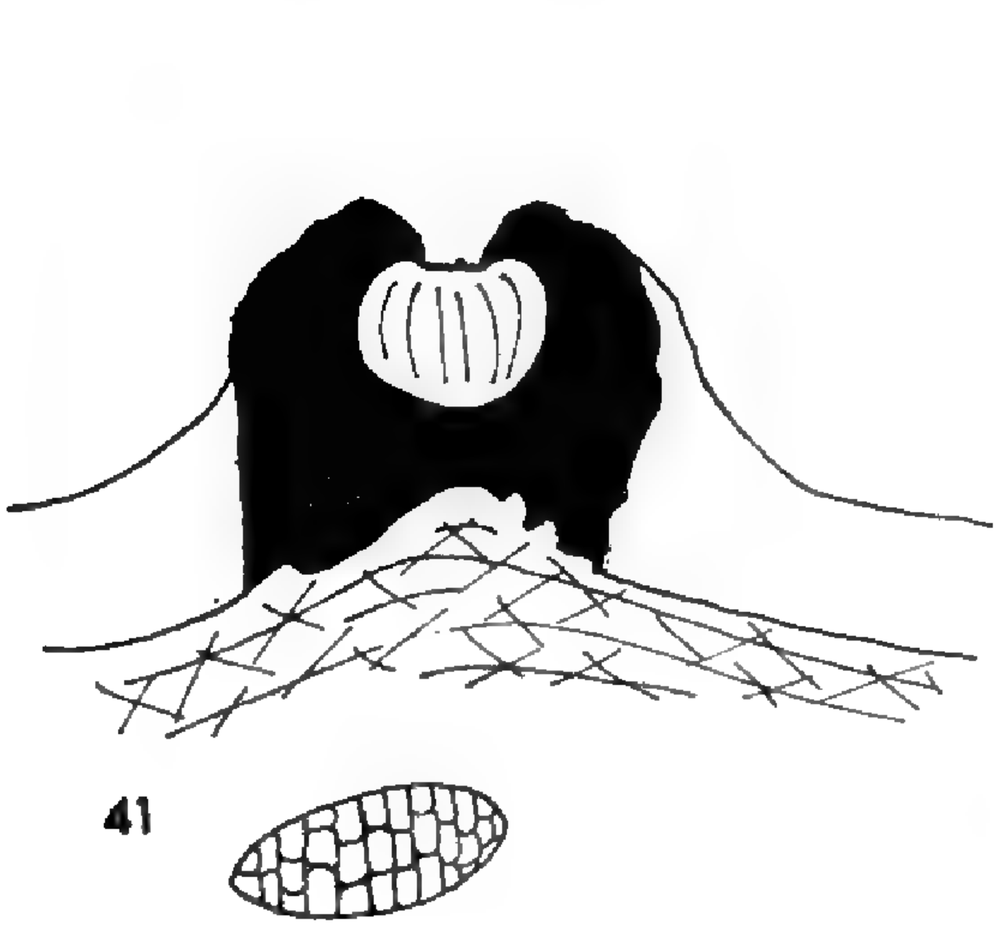


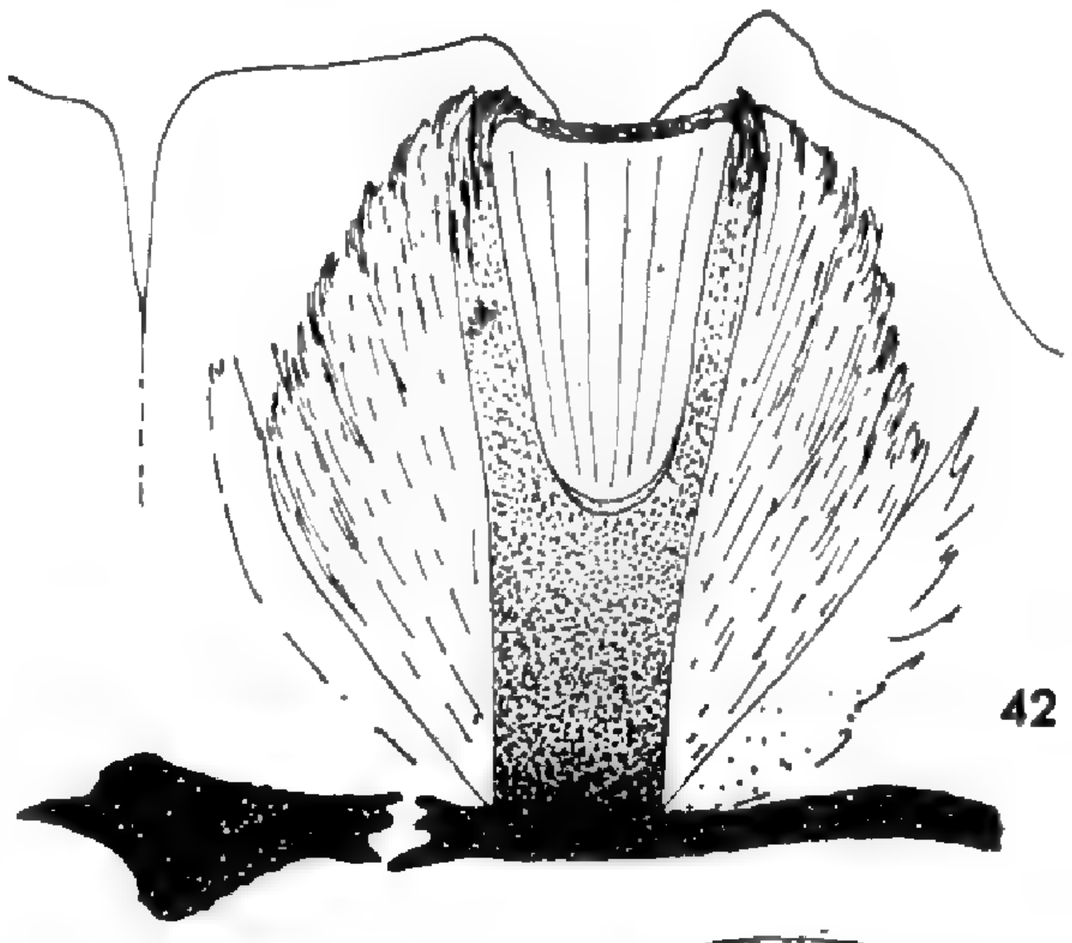
FIGURE 38.—*Graphina scolecitis* (Tuck.) Fink (isotype, *Beaumont* s.n.).





FIGURES 39–40.—39. *Graphina sulcata* Fink (holotype, *Fink* 659). 40. *G. sulcata* (*Hale* 20068).





FIGURES 41–42.—41. *Graphina sulcatula* var. *conglomerata* Müll. Arg. (*Hale* 20629). 42. *G. triangularis* Zahlbr. (isotype, *Pringle* 17).

Graphina triangularis is a distinct species, unlikely to be confused with any other. It is somewhat similar internally to *G aibonitensis* Fink, in that the labia consist of elongate striae arising from a thickened base. The unknown acid is also found in *Graphina palmeri*, *G. virginea*, and *Phaeographis exaltata*.

20. Graphina virginalis (Nyl.) Müll. Arg. Bull. Herb. Boiss. 3:47. 1895.
FIGURE 43

Fissurina virginalis Nyl. Lich. Insul. Guin. 50. 1889. Type: Florida, U.S.A. (US, isotype).

Graphis virginalis Tuck. in Eckf. Bull. Torr. Bot. Club 17:256. 1890. Based on *Fissurina virginalis* Nyl.

Graphina virginalis (Tuck.) Redgr. Ark. Bot. 26A, no. 1:58. 1933. Superfluous combination.

Thallus smooth, continuous. Ascocarps dispersed to somewhat clustered, usually lighter than the thallus, immersed to emergent, sparingly branched, straight to rather flexuose, to 3 mm. long; disc appearing first as a light colored line, then often becoming elevated and fissurine; exciple open or nearly so, colorless laterally; labia convergent, light to dark brown; hymenium about 100 μ high. Spores 8 per ascus, elliptic, often halonate, irregularly few celled, 14–18$\times$ 26–40 μ.

Reaction: KOH+ red, P—, no microchemical test made.

Specimen examined: Chiapas: El Suspiro, *Hale* 20225 (US).

Graphina virginalis is part of the *nitida-leuconephela* complex, a group in need of careful revision.

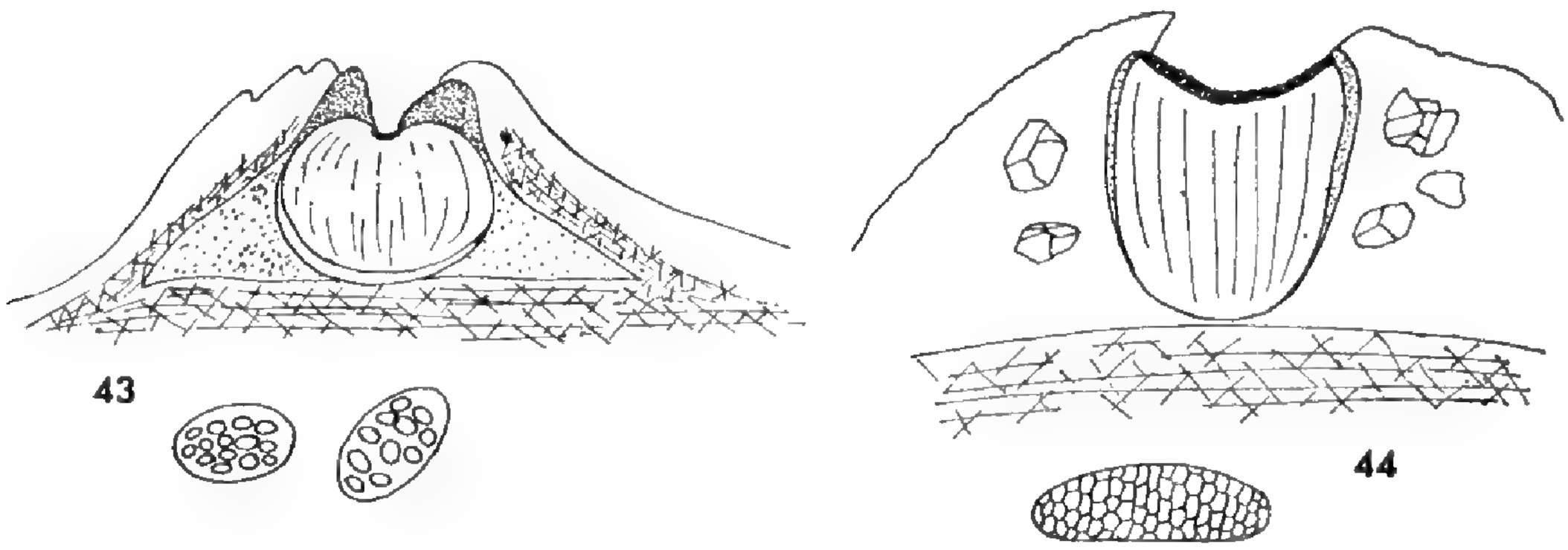
21. Graphina virginea (Eschw. in Mart.) Müll. Arg. Flora 63:41. 1890.
FIGURE 44

Leiogramma virgineum Eschw. in Mart. Fl. Bras. 1:98. 1833. Type: Near Pará, Brazil, s.c. (not seen and possibly destroyed).

Thallus thick, smooth to minutely granular, continuous or lightly fissured. Ascocarps whitish, immersed, usually asteroidly branched and intricate, 1–4 mm. long; exciple pale, rudimentary, open; labia upright, more or less separate. Spores 2–8 per ascus, elliptical or elongate, 15–25$\times$3–7 locular, 13–21$\times$50–130 μ.

Reaction: KOH+ red, unknown acid in G.A. o-T.

Specimens examined: Vera Cruz: Northeast of San Andrés Tuxtla, *Hale* 19792, northwest of Alvarado, *Hale* 19756, Orizaba, *Fr. Müller* (US).



FIGURES 43–44.—43. *Graphina virginalis* (Nyl.) Müll. Arg. (isotype). 44. *G. virginea* (Eschw. in Mart.) Müll. Arg. (*Fr. Müller* s.n.).

The Müller collection from Orizaba was identified as *Graphis cometia* Fée by Nylander (1858, p. 381), a species considered to be a synonym of *G. virginea*.

Graphina virginea seems to vary in the number of spores per ascus. Some specimens have two to three per ascus, others four to six, others six to eight, with no apparent correlations with anatomy or chemistry. The unknown acid is identical with that found in *Phaeographis exaltata*, *Graphina palmeri*, and *G. triangularis*.

2. Graphis

22. Graphis afzelii Ach. Syn. Lich. 85. 1814. FIGURES 45, 46

Holotype: Guinea, *Afzelius* (H). Isotype in UPS.

Graphis atroalba Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:123. 1890, non Kremplh. 1875. Holotype: Rio de Janeiro, Brazil, *Vainio* 189 (TUR).

Graphis atroleuca Zahlbr. Cat. Lich. Univ. 2:294. 1923. Based on *G. atroalba* Vain.

Thallus smooth, continuous. Ascocarps sessile, unbranched, usually completely covered by a white thalloid veil, 1–5 mm. long to 1 mm. wide; exciple closed, black and thick above, brown or pale below, often quite thin; labia usually entire, convergent; hymenium 75–125 μ high. Spores 8 per ascus, four locular, 6–9×16–23 μ.

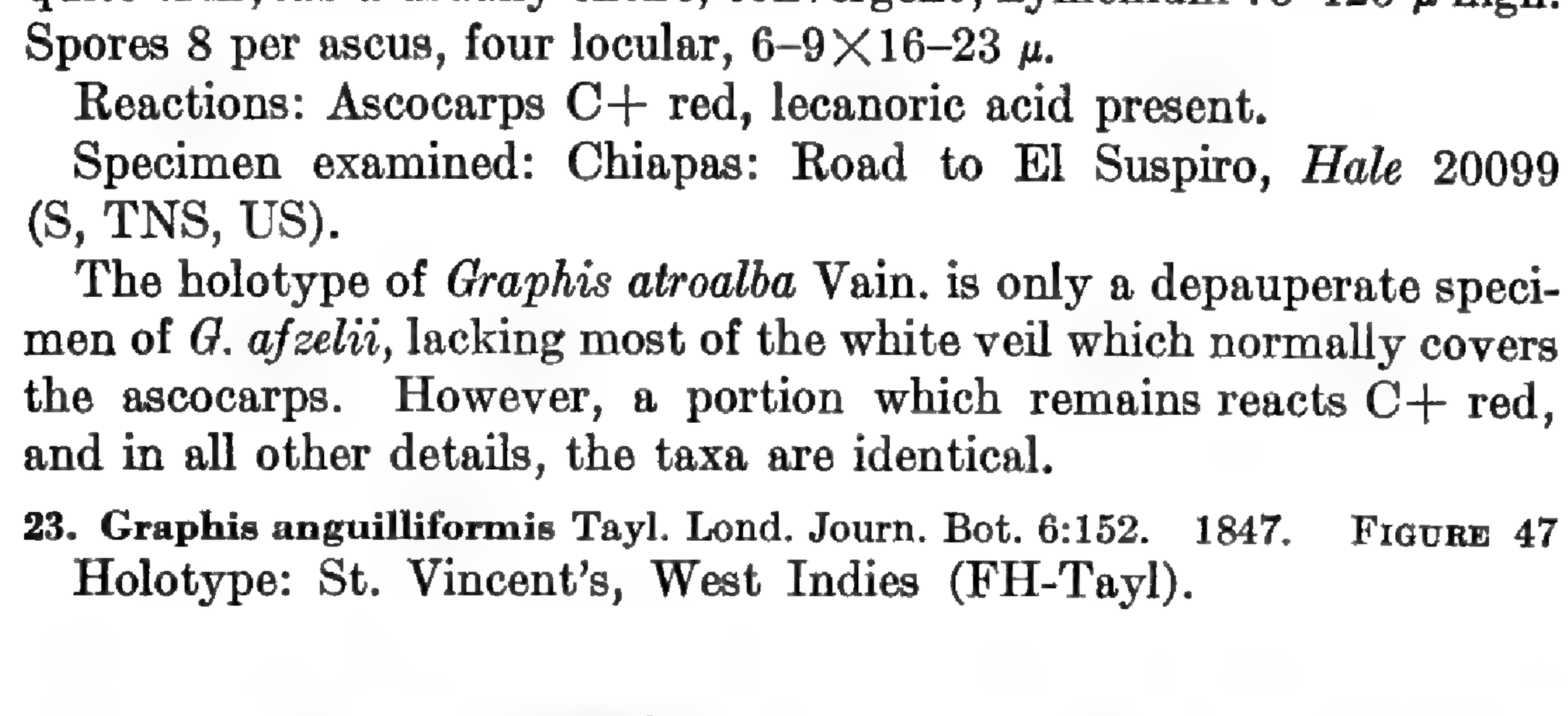
Reactions: Ascocarps C+ red, lecanoric acid present.

Specimen examined: Chiapas: Road to El Suspiro, *Hale* 20099 (S, TNS, US).

The holotype of *Graphis atroalba* Vain. is only a depauperate specimen of *G. afzelii*, lacking most of the white veil which normally covers the ascocarps. However, a portion which remains reacts C+ red, and in all other details, the taxa are identical.

23. Graphis anguilliformis Tayl. Lond. Journ. Bot. 6:152. 1847. FIGURE 47

Holotype: St. Vincent's, West Indies (FH-Tayl).



FIGURES 45–46.—45. *Graphis afzelii* Ach. (isotype). 46. *G. afzelii* (*Hale* 20099).

Thallus smooth to nodular, continuous. Ascocarps sessile, simple to 3–4 branched, 1–5 mm. long, 0.6–0.8 mm. wide, concolorous with the thallus except at the very apex which is usually black; exciple black, entire, covered almost to the apex by a thalline veil; labia entire, convergent; hymenium 175–200 μ high. Spores 2–6 per ascus, 12–18 locular, 10–13×75–100 μ long.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.

Specimen examined: Hidalgo: Honey Station, *Pringle* 10864 (MICH, VT).

Graphis anguilliformis is usually considered as a synonym of the Brazilian *G. illinata* Eschw., the type of which we have not been able to find. The Pringle material from Mexico is identical in all ways with Taylor's type, and it is perhaps best to continue using this name, which has been typified.

24. Graphis caesiella Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:122. 1890. FIGURES 48–50

Holotype: Rio de Janeiro, Brazil, *Vainio* 45 (TUR).

Graphis yaucoensis Fink, Mycologia 19:213. 1927. Holotype: Yauco, Puerto Rico, *Fink* 1691 (MICH).

Thallus continuous, smooth to minutely roughened. Ascocarps distinctly pruinose, immersed, slender, simple to branched and subintricate, often bordered by an irregular slightly raised thalline margin, 0.5–4 mm. long; exciple black, open; labia entire, divergent or slightly convergent; hymenium 75–125 μ high. Spores 8 per ascus, 6–10 locular, 6–10×20–40 μ.

Reactions: KOH+ red, norstictic acid.

Specimen examined: Tamaulipas: Tampico, *Pringle* 62 (FH, MICH).

Graphis caesiella can be separated from the other species in the *G. scripta* complex by the distinctly pruinose ascocarps. It is quite closely related to *G. subamylacea* Zahlbr., which differs only in having a closed exciple. *Graphis yaucoensis* is identical in all respects with the holotype of *G. caesiella*.

Chemically *G. caesiella* is somewhat variable outside of Mexico. The majority of 48 specimens tested contained norstictic acid, but a significant number yielded stictic or protocetraric acids. Thirty-seven specimens with norstictic acid were collected in Louisiana, Mexico, Puerto Rico, Hispaniola, Brazil, and Samoa. Seven specimens with protocetraric acid were from Florida, Cuba, Hispaniola, and Puerto Rico. Four with stictic acid were restricted to the Dominican Republic. There seems to be no correlation between the chemistry and distribution on the basis of this small sample.

25. Graphis desquamescens Fée, Bull. Soc. Bot. France 21:24. 1876. FIGURE 51

Syntypes: Brazil, *Glaziou* 5082 (M), 5016 (see below).

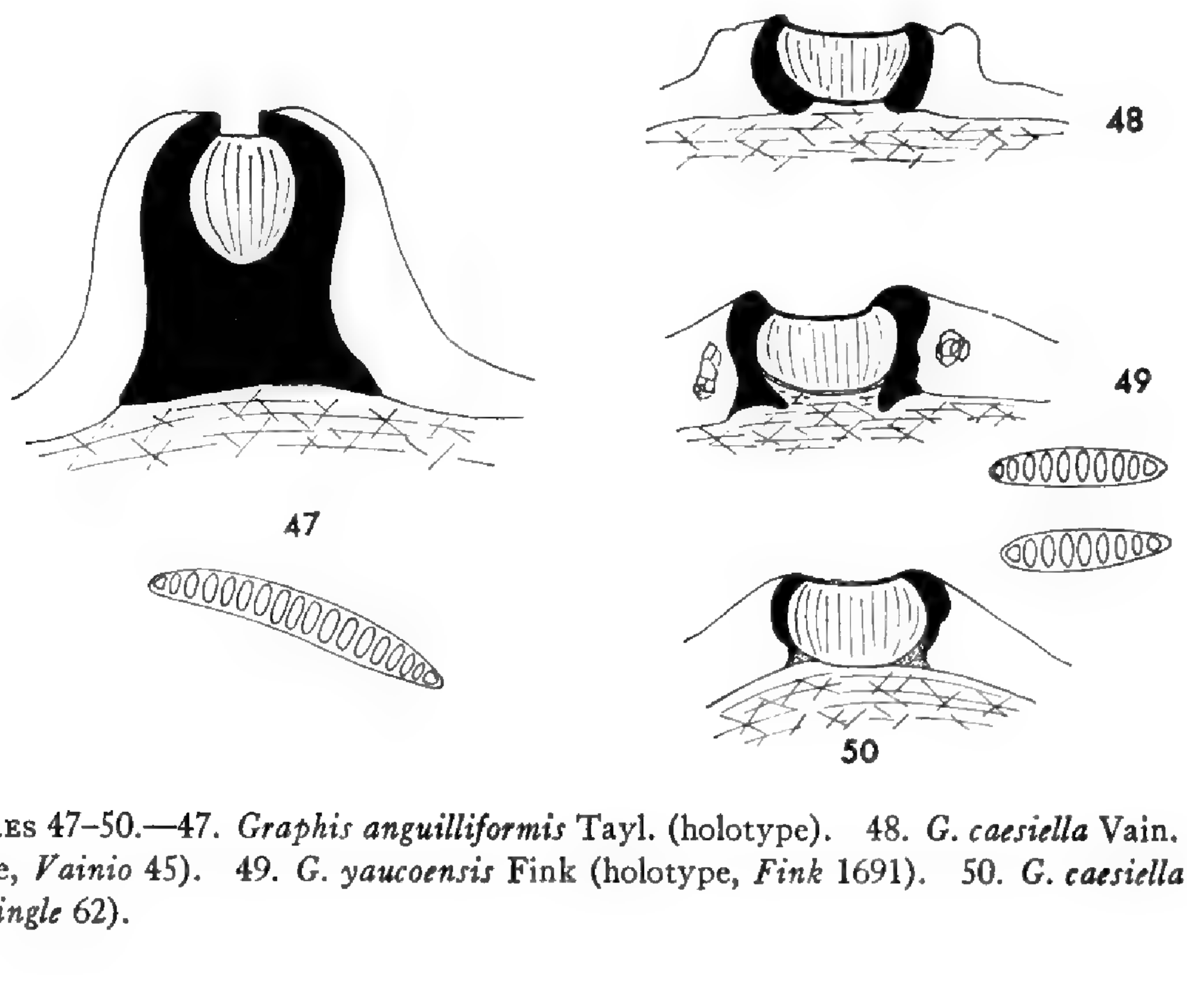
Graphis compulsa Kremplh. Flora 59:419. 1876. Based on *G. desquamescens* Fée.

Thallus continuous, minutely roughened to smooth. Ascocarps subsessile, black, *Opegrapha*-like, slender, often branched, flexuose, 0.5–3 mm. long, often with a low thalline margin; exciple closed, black; labia convergent, entire or very slightly crenate; hymenium 75 μ high. Spores 8 per ascus, 6–8 locular, 5–8×20–28 μ.

Reactions: KOH+ red, norstictic acid.

Specimen examined: Vera Cruz: East of Córdoba, *Hale* 19731 (US).

Graphis compulsa Kremplh. is a superfluous new name for *G. desquamescens* Fée and was based on *Glaziou* 5082. This specimen (M) has norstictic acid and is identical with material collected from many localities throughout the American tropics. Unfortunately we have yet to examine the other syntype of this species.



FIGURES 47–50.—47. *Graphis anguilliformis* Tayl. (holotype). 48. *G. caesiella* Vain. (holotype, *Vainio* 45). 49. *G. yaucoensis* Fink (holotype, *Fink* 1691). 50. *G. caesiella* Vain. (*Pringle* 62).

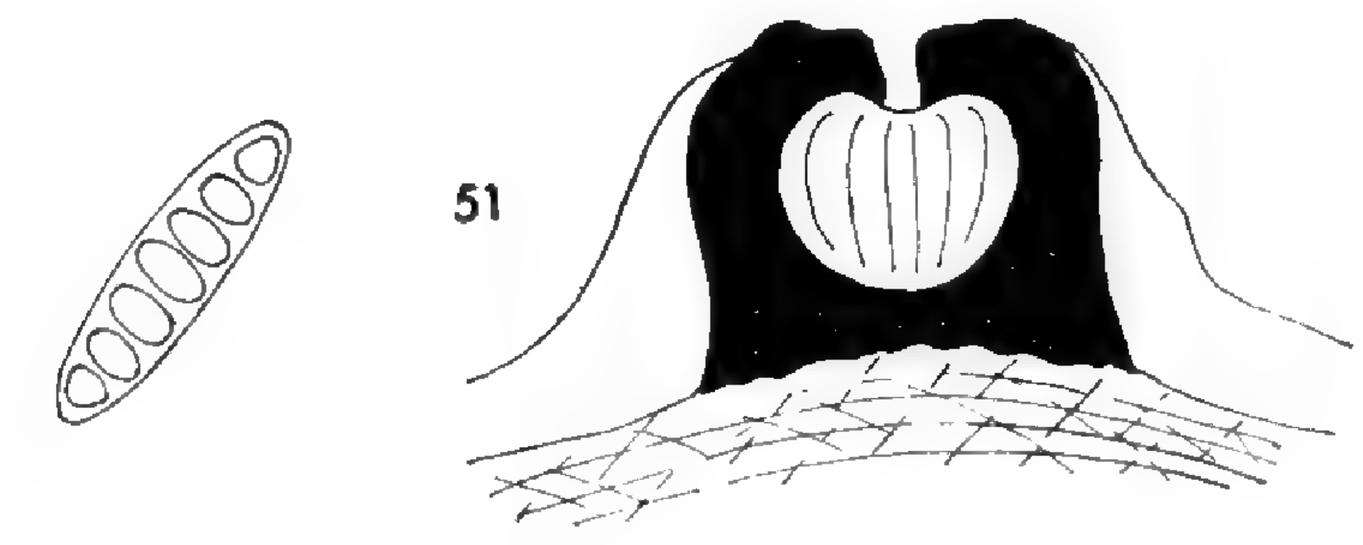


FIGURE 51.—*Graphis compulsa* Kremplh. (holotype, *Glaziou* 5082).

26. Graphis endoxantha Nyl. Bull. Soc. Linn. Norm. ser. 2, 2:110. 1868. FIGURES 52, 53

Graphis subelegans Nyl. Lich. Trop. Labuan Singapore 42. 1891. Holotype: San Luis Potosí, Mexico, *Pringle* 162 (H).

Holotype: New Caledonia, *Pancher* (H).

Thallus smooth, nitid, continuous. Ascocarps sessile, prominent, flexuose, rarely branched, 1–6 mm. long, 0.5–0.7 mm. wide; exciple nearly open to closed, usually much thickened below, yellow, with many prominent crystalline inclusions; labia with many striae, black; hymenium about 100 μ high. Spores 8 per ascus, 6–7 locular, 6–8$\times$ 25–30 μ.

Reactions: KOH+ reddish, P−, no microchemical tests made.

Specimens examined: San Luis Potosí: Las Palmas, *Pringle* 217 (VT), 166 p.p. (FH).

The holotype of *G. endoxantha* is sterile but it is unquestionably identical with *G. subelegans*. The species is closely allied to *G. proserpens* Vain., differing in the nitid thallus, the very prominent ascocarps, and the abundant excipular inclusions.

27. Graphis flexibilis Krempelh. Flora 59:414. 1876. FIGURE 54

Holotype: Brazil, *Glaziou* 5106 (M).

Thallus smooth to warty or fissured. Ascocarps sessile, black above, commonly branched, flexuose, acute, 5–13 mm. long, about 0.6 mm. wide; exciple black, closed, often thickened below; labia convergent, 1–6 sulcate, often with included crystals; hymenium 50–150 μ high. Spores 6–8 per ascus, 15–21 locular, 12–13$\times$60–105 μ.

Reaction: KOH+ reddish, P−, o-T−, G.E.− no acids demonstrated.

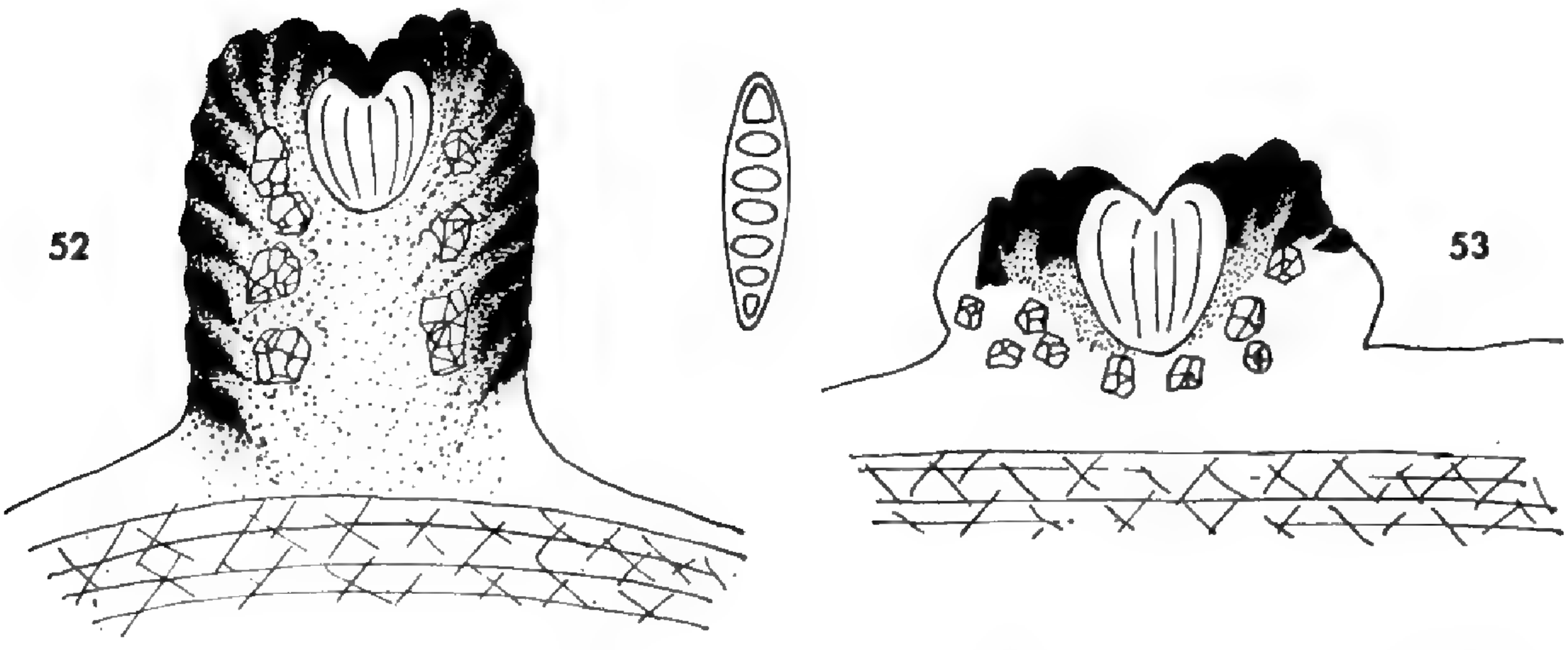
Specimen examined: Chiapas: West of Tuxtla Gutiérrez, *Hale* 19894 (US).

Zahlbruckner (1923, p. 293) placed *Graphis flexibilis* as a synonym of *G. angustata* Eschw. in Mart. As a rule, Eschweiler's types are not available for study to our knowledge, and since in this case the species cannot be typified, it seems appropriate to use Krempelhuber's name.

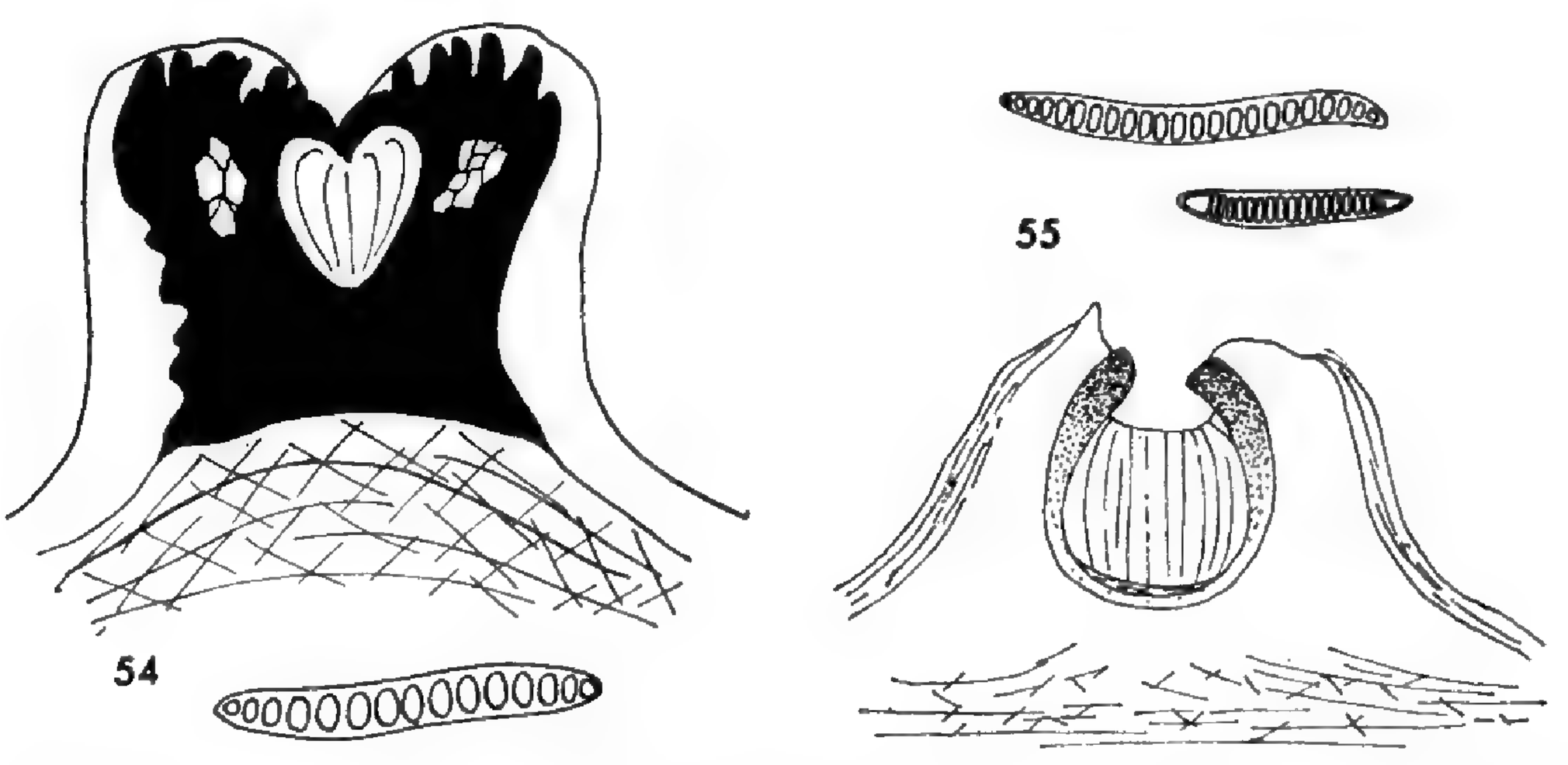
28. Graphis glaucopis sp. nov. FIGURE 55

Thallus corticola, continuus, laevis vel nitidulus, 200–250 μ crassus, strato corticale arachnoideo, 25–30 μ crasso. Apothecia subsessilia, elliptica vel oblongo-elliptica, plus minusve simplicia, 0.5–2 mm. longa, 0.4 mm. lata, albofarinosa, superne fuscescentia, excipulo plus minusve integro, pallido, labiis convergentibus, integris, fuscofuligineis; hymenium 150–200 μ altum, epithecio indictincto. Sporae 6nae, loculis 25–27, 16–26$\times$75–260 μ longae.

Reactions: Thallus KOH+ orange, P−; ascocarps KOH+ orange, P+ red, o-T−, G.E.−, no acids demonstrated.



FIGURES 52–53.—52. *Graphis subelegans* Nyl. (holotype, *Pringle* 162). 53. *G. endoxantha* Nyl. (*Pringle* 166 p.p.).



FIGURES 54, 55.—54. *Graphis flexibilis* Krempl. (holotype, *Glaziou* 5106). 55. *G. glaucopis* Wirth & Hale (holotype, *Hale* 20219).

Type in the U.S. National Herbarium, collected in Mexico, El Suspiro, Chiapas, March 22, 1960, by M. E. Hale (no. 20219) (isotypes in S, TNS).

Graphis glaucopis is somewhat difficult to place as to genus. The extremely thick thallus and the heavy walled spores indicate affinities with *Ocellularia*. However, the distinctly elliptical ascocarps, the rimiform disc, and the lack of a columella make it necessary to put the species in *Graphis*.

This species is unusual in the extreme variation in spore size to be found within a single ascocarp. Spore length is a very variable character in the majority of the species of the Graphidaceae, and *G. glaucopis* would seem to represent the extreme of this tendency.

29. Graphis grammatica Nyl. Flora 49:292. 1866. FIGURE 56

Type: Cuba (see below).

Thallus very thick, often fissured and uneven. Ascocarps densely clustered, immersed to depressed, curved and intricate, to 1 mm. long, very slender; disc light brown; exciple pale brown, closed, 150–200 μ high, heavily thickened below the hymenium. Spores 8 per ascus, 4 locular, 4–6×10–18 μ.

Reactions: KOH+ yellow, stictic acid.

Specimen examined: Chiapas: El Sumidero, Tuxtla Gutiérrez, *Hale* 20042 (US).

Graphis grammatica was originally described without citation of collector or number; "Cuba" is the only indication of provenance. Among the Wright Cuban collections, no. 36 is labeled *G. grammatica* Nyl., and these specimens (FH, US) are probably isotypes. They compare very well with the Mexican material (which is sterile), except that *Wright* 36 yielded no stictic acid.

30. Graphis implicata Fée, Bull. Soc. Bot. France 21:27. 1874. FIGURES 57–59

Graphis chlorocarpella Nyl. in Krempth. Flora 59:413. 1876. Based on *G. implicata* Fée.

Graphis balbisina Nyl. Lich. Trop. Singapore et Labuan 42. 1891. Type: Mexico (see below).

Type: Brazil, *Glaziou* 5036 (MICH, isotype). Reactions: too fragmentary to test.

Thallus continuous or fissured, often uneven. Ascocarps semi-emergent to subsessile, lighter than the thallus, occasionally branched, flexuose and somewhat intricate; exciple closed or nearly so, reddish or yellowish brown; labia lightly sulcate, convergent, often with darkened apices. Spores 8 per ascus, 11–21 locular, 11–13×52–107 μ.

Reactions: KOH+ red, norstictic acid.

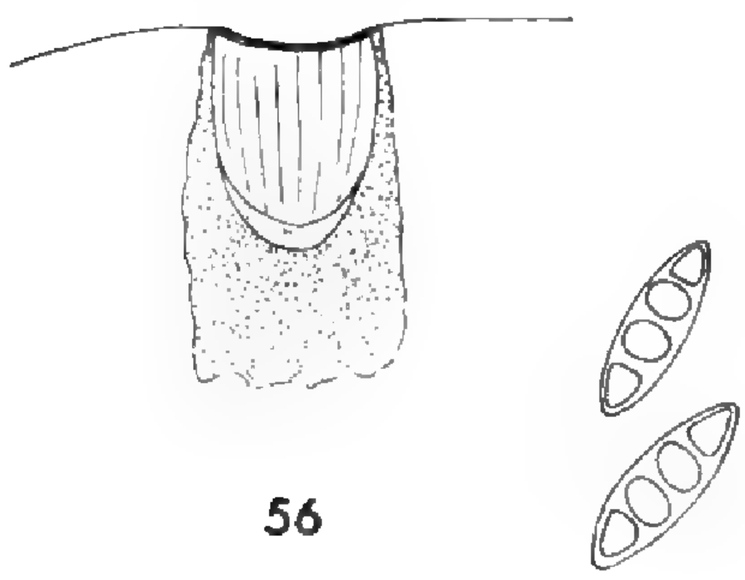
Specimens examined: Nuevo León: Monterrey, *Pringle* 118, 119 (FH, US, VT).

Both *Graphis implicata* and *G. chlorocarpella* are based on *Glaziou* 5036, and are therefore synonymous, as has already been pointed out by Zahlbruckner (1909, p. 108). The isotype in Fink's herbarium is too fragmentary to test; *Pringle* 119 yielded an extremely small amount of norstictic acid.

Graphis balbisina Nyl. was described from Mexico with Eckfeldt as the collector. One year later Eckfeldt (1892, p. 253) listed this species from Mexico, under Pringle's collection 118. It may therefore be assumed that this was the specimen on which Nylander based his description and should be considered as the type (isotypes in FH, US, VT). Nylander's dealings with Eckfeldt are frequently marked by confusion.

31. Graphis longula Krempth. Flora 59:414. 1876. FIGURE 60

Phaeographis longula (Krempth.) Zahlbr. Denkschr. Akad. Wiss. Wien 83:109. 1909.



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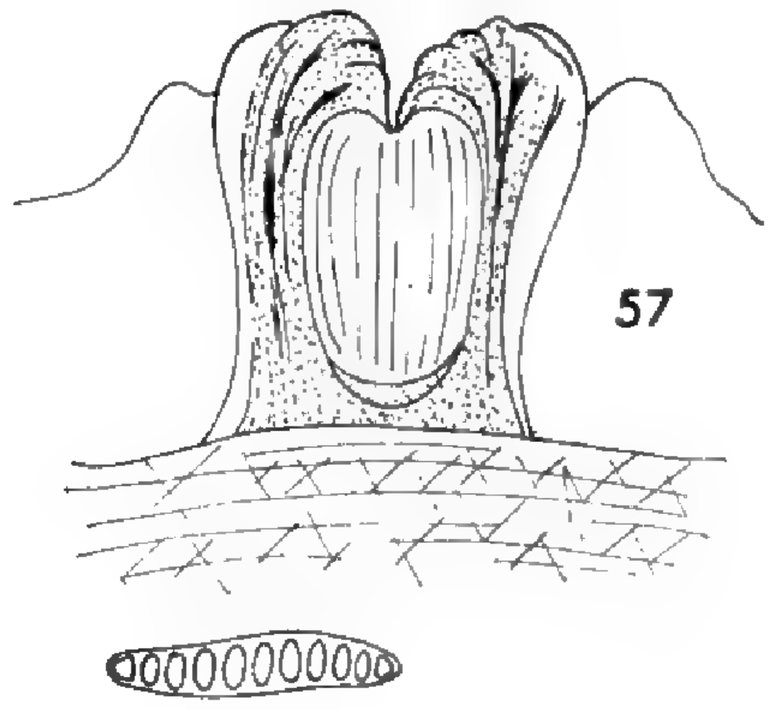

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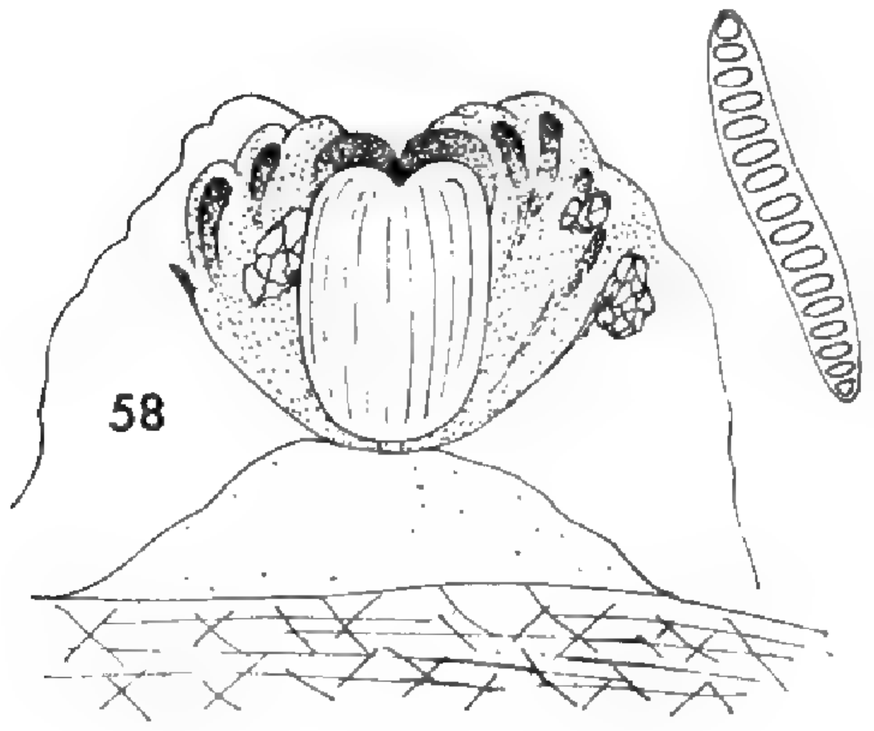

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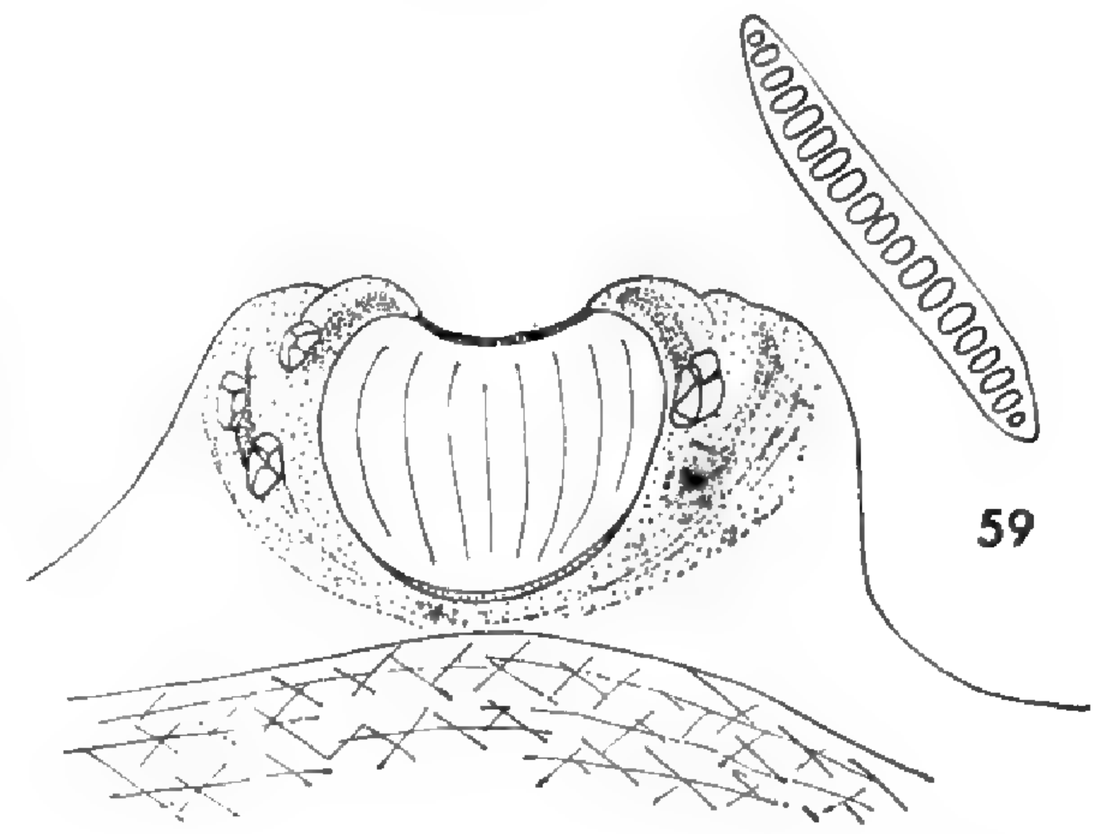

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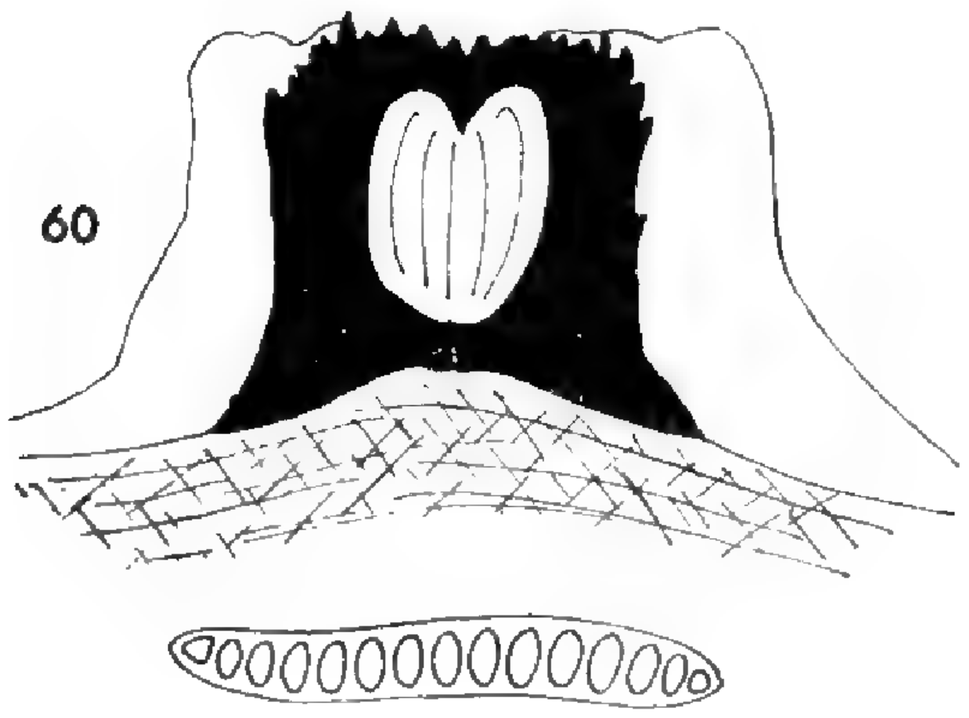
FIGURES 56–59.—56. *Graphis grammatica* Nyl. (*Wright* 36). 57. *G. implicata* Fée (isotype, *Glaziou* 5036). 58. *G. balbisina* Nyl. (isotype, *Pringle* 118). 59. *G. implicata* Fée (*Pringle* 119).

Holotype: Brazil, *Glaziou* 5497 (M).

Thallus smooth to minutely roughened, continuous. Ascocarps black above, slender, subsessile, elongate, quite flexuose, occasionally branched, 2–10 mm. long, often with a low thalline margin; exciple black, closed; labia convergent, crenate to dentate; hymenium 80–90 μ high. Spores 2–6 per ascus, colorless, 10–17 locular, 9–13×(40)75–90 μ.

Reactions: KOH— or KOH+ yellow, P—, no acids demonstrated.



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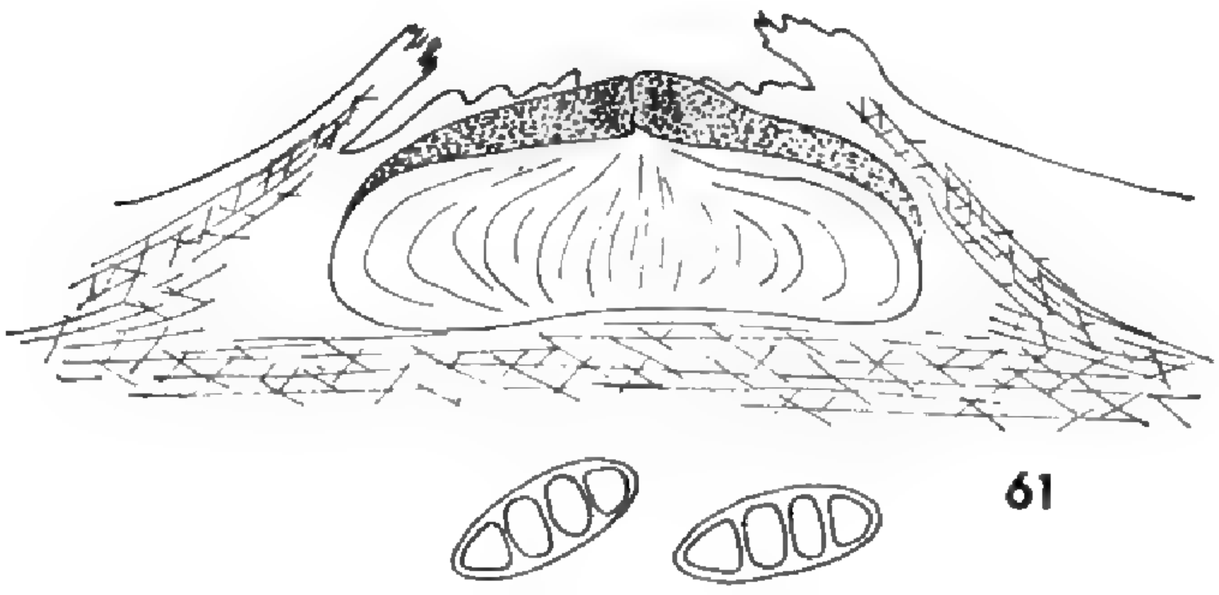


61

FIGURES 60, 61.—60. *Graphis longula* Kremplh. (holotype, *Glaziou* 5497). 61. *G. platycarpella* Müll. Arg. (*Pringle* 210).

Specimen examined: Chiapas: North of Berriozábal, *Hale* 20225 (US).

The spores of *Graphis longula* are quite colorless at maturity, and Zahlbruckner's transfer to *Phaeographis* is unnecessary. It is possible, however, that this species may be referable to *Graphis angustata* Eschw. in Mart.

32. Graphis platycarpella Müll. Arg. Bull. Soc. Bot. Belg. 30:81. 1891. FIGURE 61

Type: Baie de Salinas, Costa Rica, *Pittier* 5236 (not seen).

Thallus smooth, continuous, fairly thick. Ascocarp immersed, round to lirelline, usually unbranched and aggregated, 1–3 mm. long, 0.5–1 mm. wide; thalline margin prominent, white, mealy, erect and flaring, exposing a flat irregular "disc" (actually the excipular labia); exciple open or partially closed, pale and thin laterally; labia thick, light to dark brown, entire, convergent; hymenium 100–150 μ high. Spores usually 4–8 per ascus, 4 locular, 6–12× 12–26 μ.

Reactions: KOH—, P—, o-T—, no acids demonstrated.

Specimen examined: San Luis Potosí: Las Palmas, *Pringle* 210 (FH, VT).

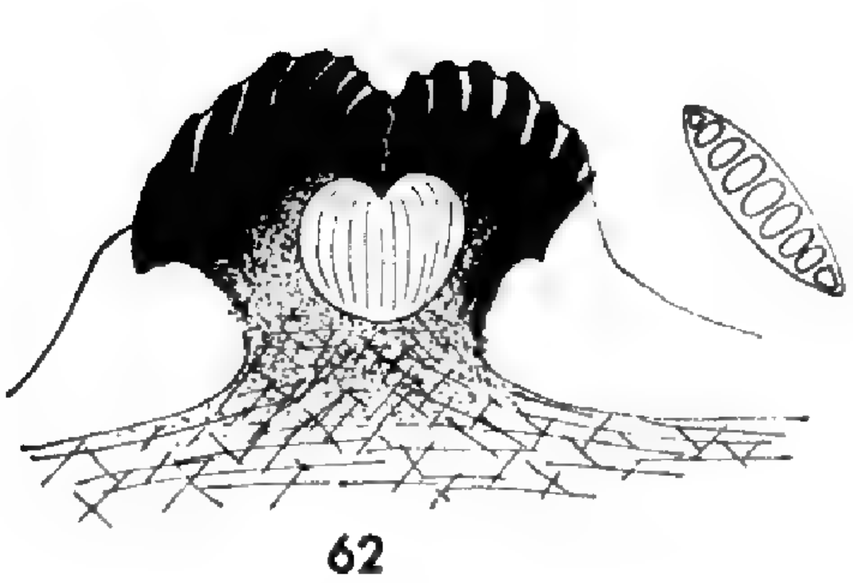
The Pringle material was reported as "*Graphis lactea* Nyl." [=*Graphis lactea* (Fée) Sprengl.] by Eckfeldt (1892, p. 252). However, a fragmentary isotype of *Fissurina lactea* Fée (H) differs internally from the Mexican material. The description of *Graphis platycarpella* is more in accord with *Pringle* 210 and this specimen is tentatively identified as such. This entity is part of the complex series of *Graphis* species which are characterized by 4 locular spores, pale exciples, and more or less fissurine ascocarps. Such species as *Graphis durandi* Müll. Arg., *G. grossula* Müll. Arg., *G. humilis* Vain., *G. lecanorina* Müll. Arg., *G. schizogramma* Vain., and *G. stromatoides* Magn. should be carefully compared in an effort to determine reliable species criteria in this alliance. This group should also be examined with regard to its relationship with the *Graphina nitida-leuconephela-mexicana* complex.

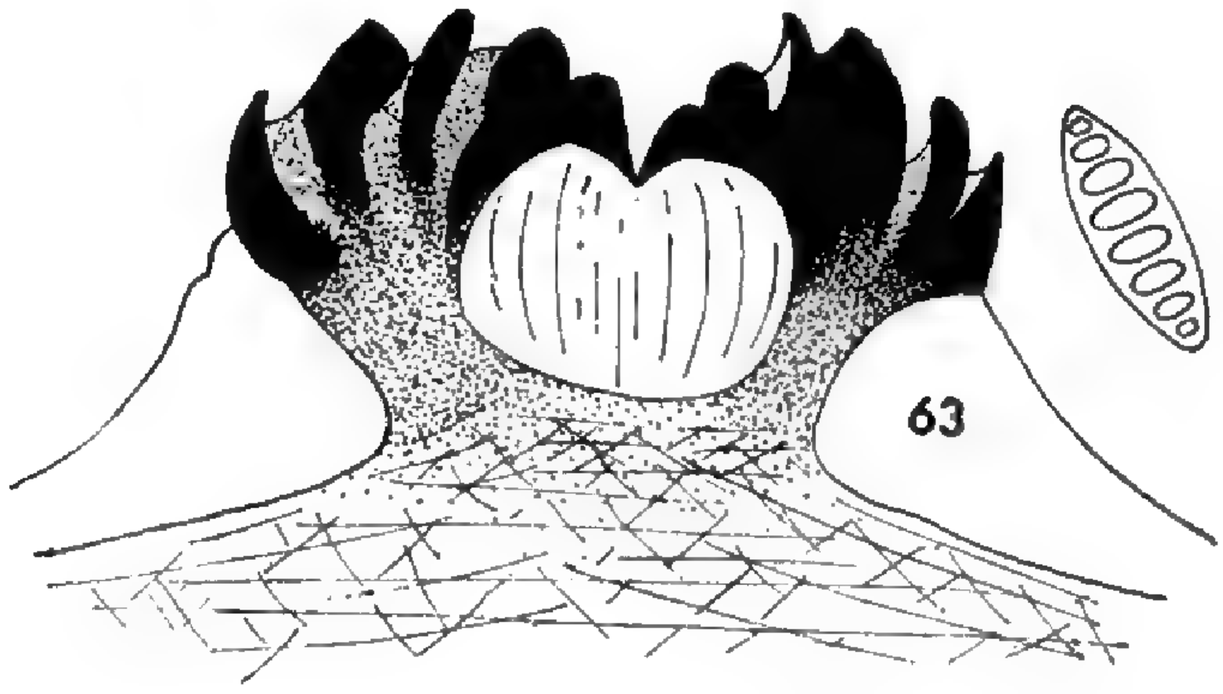
33. Graphis proserpens Vain. Bot. Tidsskr. 29:132. 1909. FIGURES 62, 63

Graphis disserpens Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:123. 1890, non *G. disserpens* Nyl. Holotype: Sitio, Minas Gerais, Brazil, *Vainio* 1091 (TUR).

Thallus smooth, continuous. Ascocarps unbranched, subsessile, 1–4 mm. long, 0.2–0.5 mm. wide, black, occasionally with a small lateral thalline margin; exciple black above, red-brown laterally, suffused below, open or nearly closed; labia convergent, 4–7 striate; hymenium 50–60 μ high. Spores 6–8 per ascus, 7–9 locular, 7–8× 18–28 μ.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.





FIGURES 62, 63.—62. *Graphis proserpens* Vain. (holotype, *Vainio* 1091). 63. *G. proserpens* (*Pringle* 15423).

Specimens examined: Morelos: Near Cuernavaca, *Pringle* 15380 (FH), 15423 (FH, VT).

The name *Graphis disserpens* Vain. was apparently a *lapsus calami*, as Vainio mentioned *G. disserpens* Nyl. in his original description. Vainio himself proposed a new name in 1909.

Graphis proserpens is part of the *rimulosa-elegans-duplicata-striatula* complex. It is possible that further study may prove these entities to be synonymous. Separating them on excipular characters seems rather difficult at the present time.

34. Graphis stygioarachnoidea, sp. nov. FIGURE 64

Thallus corticola, continuus, 38–42 μ crassus, strato corticale arachnoideo, 13–15 μ crasso. Apothecia dispersa, subsessilia, flexuosa, lirellina, raro furcata, 2–5 mm. longa, 0.3–0.4 mm. lata, quam thallo pallidiore, excipulo plus minusve integro, pallido, labiis convergentibus, fuscescentibus; hymenium 100–120 μ altum. Sporae 8nae, 5.5–8× 22–42 μ, loculis 11–16.

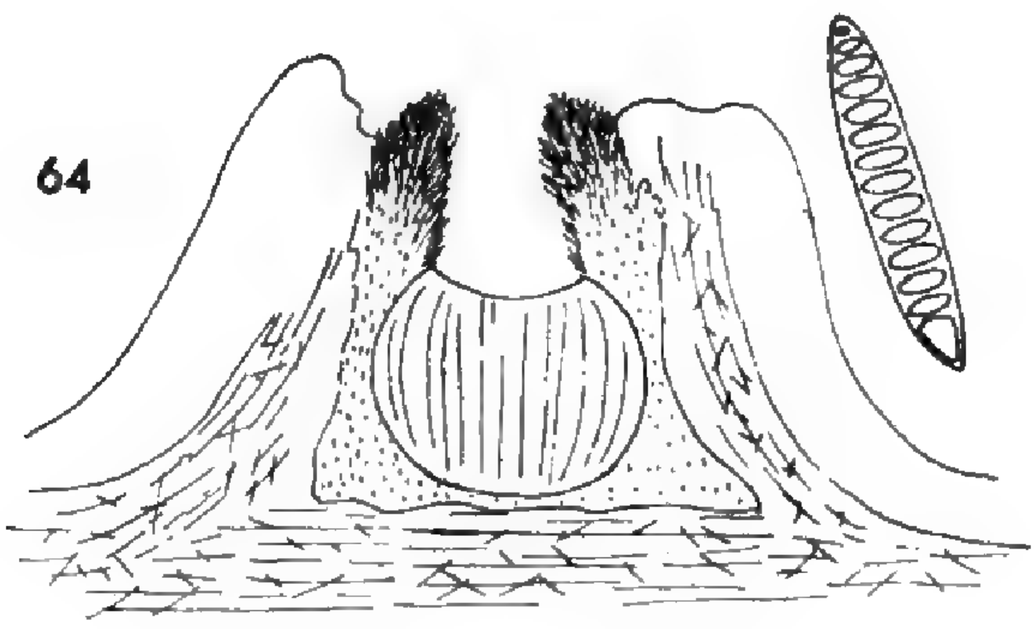


FIGURE 64.—*Graphis stygioarachnoidea* Wirth & Hale (holotype, *Hale* 20399).

Reactions: KOH+ reddish, P+, o-T—, no acids demonstrated.

Type in the U.S. National Herbarium, collected in Mexico, Lagos de Monte Bello, Chiapas, March 25, 1960, by M. E. Hale (no. 20399).

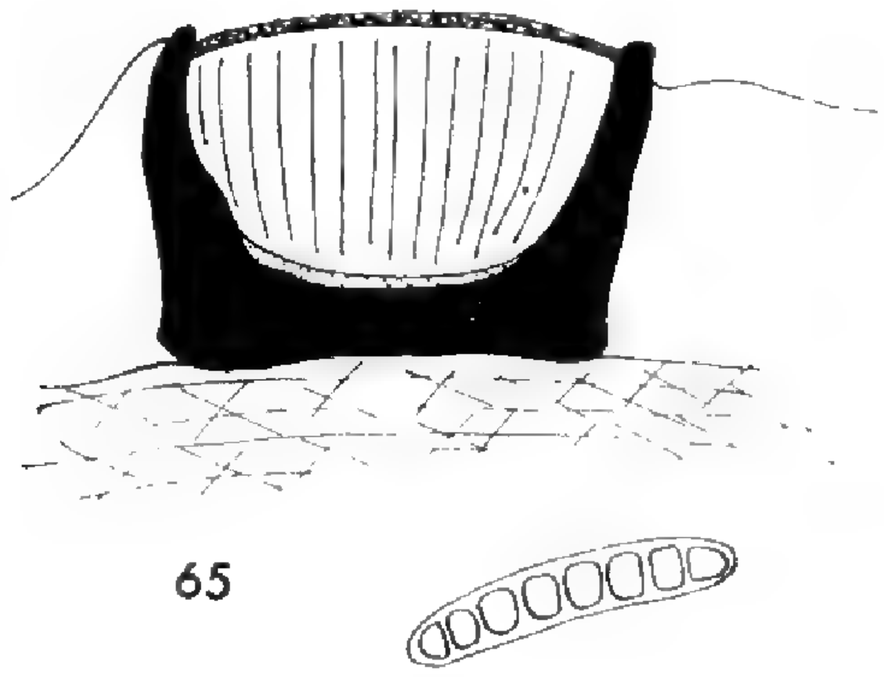
This new species is quite closely related to *G. mosquitensis* Tuck., from which it differs in having the hyphae of the labia free and

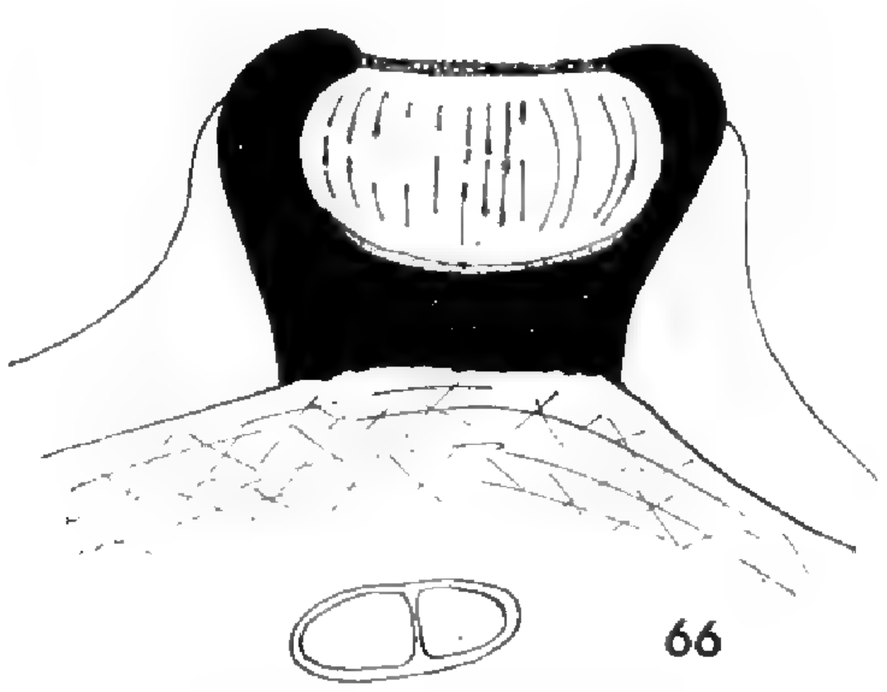
distinctly carbonized, and in the more robust, nearly sessile ascocarps. Although the labia in the holotype of *G. mosquitensis* occasionally show an apical looseness of construction, these hyphae never become free or distinctly black and carbonized.

35. Graphis subamylacea Zahlbr. Ann. Mycol. 19:229. 1921. FIGURE 65

Type: Cuernavaca, Morelos, Mexico, *Pringle* 24 (MICH, isotype).

Thallus continuous, to 100 μ thick, smooth or minutely roughened. Ascocarps immersed, very variable, slender, much branched, often radiate or anastomosing, 1–5 mm. long, about 0.3 mm. wide, level with the thallus or sometimes bordered by very low thalline margins, lightly pruinose or black; exciple black, usually closed; labia entire, divergent; hymenium 100–120 μ high, opaque. Spores 8 per ascus, 6–8 locular, 5–8×17–30 μ.





FIGURES 65, 66.—65. *Graphis subamylacea* Zahlbr. (isotype). 66. *Melaspilea polymorpha* Müll. Arg. (holotype, *Pringle* 98).

Reactions: KOH+ yellow, stictic acid.

Specimen examined: Tamaulipas: Tampico, *Pringle* 412 (MICH).

This species, though fairly distinct, is extremely variable in the form, size, and pruinosity of the ascocarps, the isotype has ascocarps ranging from quite small and highly pruinose to large and almost black. The second collection (*Pringle* 412) is more robust, and externally much like *Graphis caesiella* Vain.

3. Melaspilea

36. Melaspilea polymorpha Müll. Arg. Bull. Herb. Boiss. 2:92. 1894.
FIGURE 66

Holotype: Near Monterrey, Mexico, *Pringle* 98 (G).

Thallus thin, smooth. Ascocarps sessile, unbranched, slightly flexuose, to 1 mm. long; exciple black, closed; labia entire, convergent but exposing a fairly wide disc; hymenium about 60 μ high. Spores 2 locular, brown, 4–8 per ascus, 5–7×14–17 μ.

Reactions: KOH−, P−, no acids demonstrated.

4. Phaeographina

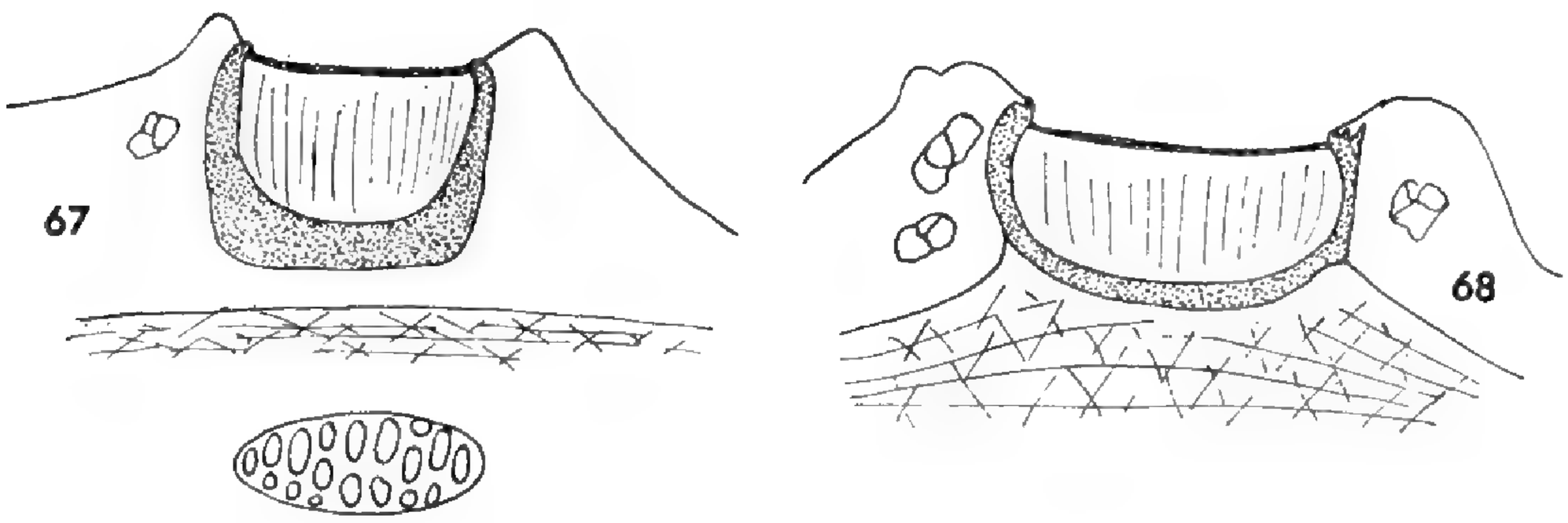
37. Phaeographina asteroides Fink, Mycologia 19:218. 1927. FIGURES 67, 68
Phaeographina caesiopruinosella Fink, Mycologia 19:219. 1927. Holotype: Naranjito, Puerto Rico, *Fink* 140 (MICH).

Holotype: Mayagüez, Puerto Rico, *Fink* 981 (MICH).

Thallus smooth, continuous. Ascocarps usually much branched, 1–3 mm. long, 0.3–0.7 mm. wide, emergent to subsessile; thalline margin more or less prominent, often somewhat lighter than the thallus; disc (and often the whole ascocarp) pruinose; exciple brownish, closed; labia entire, more or less divergent. Spores 8 per ascus, brown, 5–10×2–3 locular, 8–18×25–50 μ.

Reactions: KOH+ red, P—, o-T—, no acids demonstrated.

Specimen examined: San Luis Potosí; Las Palmas, *Pringle* 224 (FH, VT).



FIGURES 67, 68.—67. *Phaeographina asteroides* Fink (holotype, *Fink* 981). 68. *P. caesiopruinosella* Fink (holotype, *Fink* 140).

Pringle 224 was reported by Müller (1894, p. 92) as *Graphina caesioradians* (Leight.) Müll. Arg. [=*Phaeographina caesioradians* (Leight.) Redgr.]. Redinger (1933, p. 99) placed both of Fink's species in synonymy of *P. caesioradians*, but since the type of the Leighton species has not been examined and since Redinger has incorrectly handled other Fink species, this synonymy cannot be verified. In any event, the two Puerto Rican species are identical (except for a slight difference in spore size), and the Pringle material is within the range of variation shown in the Puerto Rican types.

38. Phaeographina caesiopruinosa (Fée) Müll. Arg. Mem. Soc. Phys. Hist. Nat. Genève 29, no. 8:49. 1887. FIGURE 70
Arthonia caesiopruinosa Fée, Suppl. Essai Crypt. Ecorces 36, *pl. 40, fig. 4*, 1837. Type: Tropical America (not seen).

Thallus smooth to slightly roughened, continuous. Ascocarps large, emergent to subsessile, elongate, to nearly round, occasionally branched, 1–10 mm. long, 1–3 mm. wide, with a wide, usually prominent, elevated thalline margin; disc flat, lightly to heavily pruinose;

exciple black, open to nearly closed, usually black laterally and absent below; hymenium 100–250 μ high, clear or inspersed. Spores 8 per ascus, gray to brown, 10–20×2–6 locular, 15–20×45–120 μ.

Reactions: KOH+ reddish or yellow.

Specimens examined: Chiapas: El Suspiro, *Hale* 20133, 20215; west of Tuxtla Gutiérrez, *Hale* 19903 (US). Nuevo León: Monterrey, *Pringle* 113 (FH, VT, US). Vera Cruz: North of Fortín de las Flores, *Hale* 19695; north of Huatusco, *Hale* 19482 (US).

Examination of a large number of specimens from the southern United States and tropical America referable to this common species indicated an intergrading series of excipular forms, varying from completely dimidiate to distinctly carbonized below. There is also intergradation between heavily inspersed hymenia and clear hymenia, elongate nearly unbranched ascocarps and stout lobulate ascocarps. None of these characters seem to show any mutual interrelation. For the moment, it seems best to treat the aggregate as a single widespread variable species.

39. Phaeographina chrysocarpa (Raddi) Redgr. Ark. Bot. 26A, no. 1:83. 1933. FIGURE 69

Opegrapha chrysocarpa Raddi, Atti Soc. Ital. Sci. 344. 1820. Type: Mandioca, Brazil (not seen).
Graphis chrysocarpa (Raddi) Sprengl. Syst. Veg. 4:253. 1827.
Graphina chrysocarpa (Raddi) Müll. Arg. Flora 63:41. 1880.
Graphis miniata Redgr. Ark. Bot. 27A, no. 3:26. 1935. Syntypes: Brazil, *Mosén* 3145, 3313, 3577 (S).

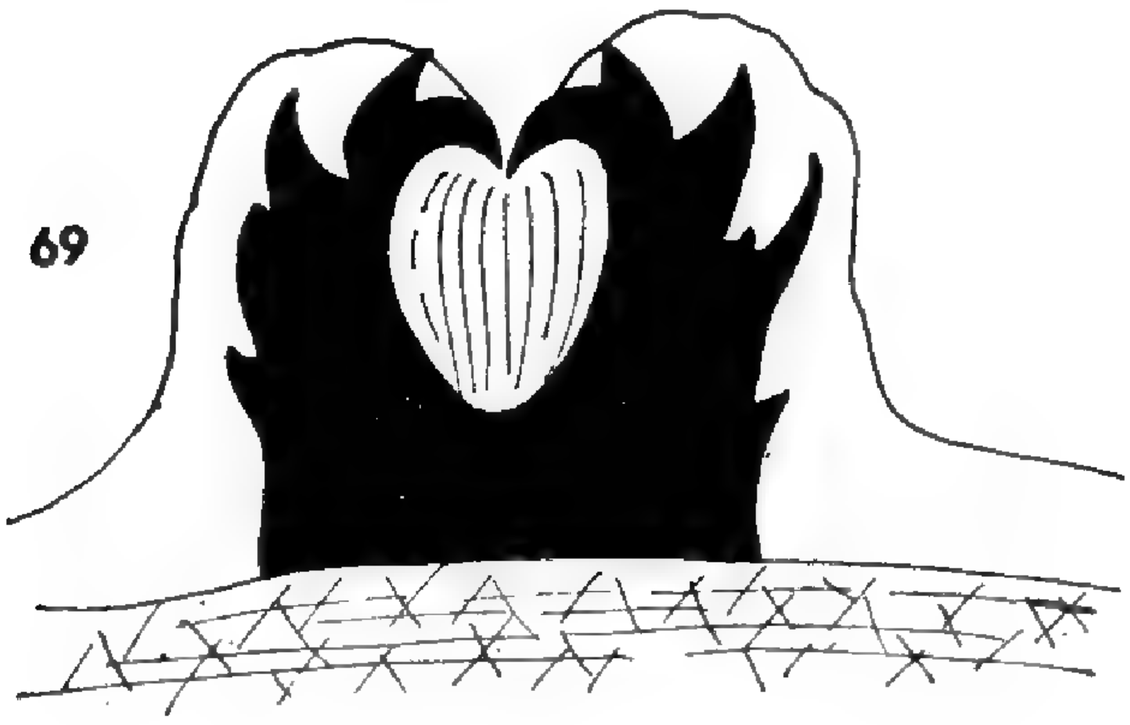
Thallus smooth, continuous. Ascocarps subsessile to sessile, unbranched to asteroidly branched, straight to quite curved, 1–7 mm. long, more or less covered by a cinnabar-red thalline veil, black beneath; exciple black, closed; labia convergent, striate. Spores 4–6 per ascus, colorless, brown, or gray, transversely septate or bi-ocellate at the ends to completely muriform, 10–15×65–150 μ long.

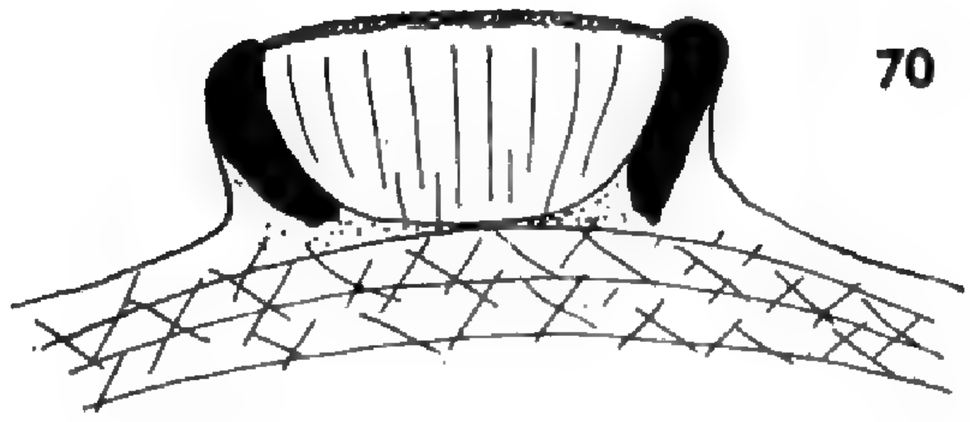
Reactions: Thallus KOH—, P—, no acids demonstrated; ascocarps KOH+ purple.

Specimen examined: Chiapas: El Suspiro, *Hale* 20173 (S, TNS, US).

Phaeographina chrysocarpa is distinguished by its brilliantly colored cinnabar ascocarps. The large series of specimens examined from tropical America showed great variation in spore septation and color. In fact, it was possible to find specimens with cinnabar ascocarps and black closed exciples which could be referred to *Graphis*, *Graphina* *Phaeographis*, or *Phaeographina*. In some cases a single specimen could be assigned to all four genera. As shown in the list of synonyms, this entity has already been placed in three of these genera.

The variation in spore characters throws considerable doubt on the validity of the four traditional genera. Specimens are usually identi-





FIGURES 69, 70.—69. *Phaeographina chrysocarpa* (Raddi) Redgr. (*Hale* 20173). 70. *P. caesiopruninosa* (Fée) Müll. Arg. (*Pringle* 113).

fied as *P. chrysocarpa* on the basis of the cinnabarine ascocarps and entire exciples, regardless of variation in the spores. Is it not possible that other species, especially those lacking such an obvious unifying feature as a pigmented ascocarp, may be assigned to several different genera, when in fact they are simply a single species with polymorphic spores? One may suggest as an example the mass of species which cluster about *Graphina acharii.*

It should also be noted that the cinnabarine ascocarp covering in *P. chrysocarpa* sometimes becomes quite reduced, occurring only at the ends of the lirellae. If this pigmented covering disappeared completely, the resulting species would be very close to *Graphina acharii,* a species which shows similar spore variation. The implication of this is obvious.

One of the syntypes of *Graphis miniata* Redgr. has brown, muriform spores, and it is therefore included in synonymy here. Actually the structure of the ascocarp in this species as illustrated by Redinger is inaccurate; internally *G. miniata* is exactly like typical *Phaeographina chrysocarpa.*

One other species in the Graphidaceae occurs with bright cinnabar ascocarps, *Graphina malmei* Redgr. The holotype (Brazil, *Malme* 3508, S) is indeed distinct, as the exciple is pallid below, and the labia constructed of free lamellae. A second collection from Brazil (*Weir* 6223, BPI) confirms the validity of this species.

40. Phaeographina sp. FIGURE 71

Phaeographina scalpturata auct. non (Ach.) Müll. Arg.

Thallus continuous, smooth to roughened. Ascocarps sessile, very large, sparingly branched, acute, straight to nearly intricate, to 15 mm. long and nearly 2 mm. wide, with a prominent elevated, light-colored thalline margin; disc flat, caesiopruinose; exciple carbonized, dimidiate or sometimes barely closed below. Spores 1 per ascus, brownish, 20–35×150–200 μ, densely muriform.

Reactions: KOH+ red, norstictic acid.

Specimens examined: Chiapas: West of Tuxtla Gutiérrez, *Hale* 19898 (US). San Luis Potosí: Canoas, *Pringle* 305 (VT). Vera Cruz: Northeast of Huatusco, *Hale* 19453; north of Fortín de las Flores, *Hale* 19696, 19704 (US).

An examination of an isotype of *P. scalpturata* (Ach.) Müll. Arg. (see p.110) disclosed that the traditional concept of the species is incorrect. The entity described above, often identified as *P. scalpturata* by such workers as Nylander, Müller, and Redinger, differs considerably from authentic material of that species. The present entity has enormous ascocarps, carbonized exciples, prominent thalline margins, and very large spores; it is extremely widespread and common and must certainly have a valid name, although we have not yet been able to determine what it might be.

41. Phaeographina strigops sp. nov. FIGURE 72

Thallus corticola, continuus, nitidus, 100–170 μ crassus, strato corticale arachnoideo, 13–15 μ crasso. Apothecia elongata, flexuosa et intricata, 4–5 ramulosa, 1–5 mm. longa, 0.1–0.3 mm. lata, disco dilatato, concavo, excipulo integro, fuscorufescente, tenue, labiis integris, divergentibus; hymenium semicirculare, 90–100 μ altum. Sporae 8nae, fuscescentes, 9–13×18–21 μ, loculis horizontalibus 5–6, loculis transversis 1–2.

Reactions: KOH+ yellow, P—, o-T unknown acid.

Type in the U.S. National Herbarium, collected in Mexico, Lagos de Monte Bello, Chiapas, March 25, 1960, by M. E. Hale (no. 20383).

This new species is allied to the Brazilian *P. oxalifera* Redgr., from which it differs in having a black disc, elongate, intricate ascocarps, and an unknown acid instead of norstictic acid.

42. Phaeographina elliptica, sp. nov. FIGURE 73

Thallus corticola, continuus vel fissus, laevis, 100–150 μ crassus, strato corticale subcellulare, 60–75 μ crasso. Apothecia immersa, simplicia, vulgo recta, elliptica vel sublirellina, apicibus rotundatis, 0.75–2 mm. longa, 0.3–0.5 mm. lata, disco planato vel concavo, nigro vel leviter pruinoso, labiis integris, divergentibus, tenuibus; hymenium inspersum, crystallis magnis decoloratis includentibus, 120–150 μ altum, epithecio fusco. Sporae fuscescentes, 1nae, 23–26×90–110 μ, loculis horizontalibus 22–25, loculis transversis 2–6.

Reactions: KOH+ orange, P—, unknown crystals in o-T.

Type in the U.S. National Herbarium, collected in Mexico, north of Berriozábal, Chiapas, March 22, 1960, by M. E. Hale (no. 20088).

Phaeographina elliptica is closely related to *P. scalpturata* (Ach.) Müll. Arg., differing primarily in the peculiar crystalline inclusions in the hymenium. In addition, the thallus shows considerable fissuring,

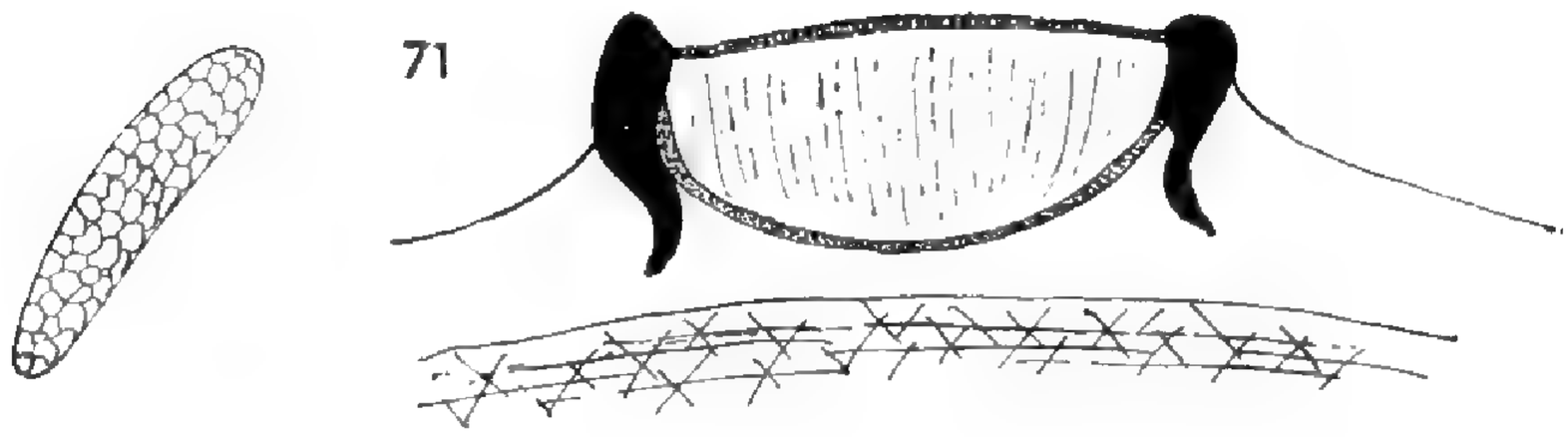
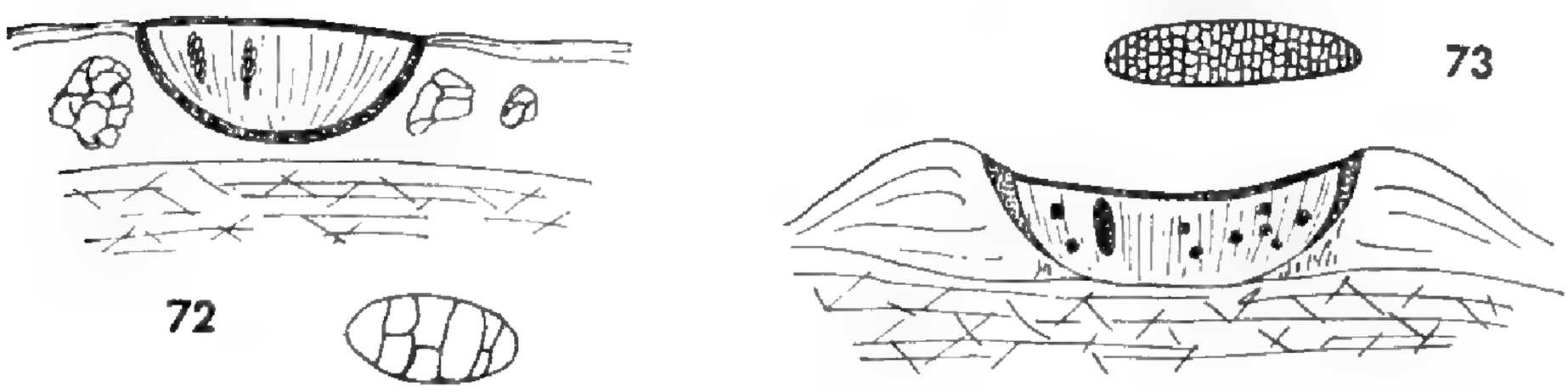


FIGURE 71.—*Phaeographina* sp. (*Hale* 19453).



FIGURES 72, 73.—72. *Phaeographina strigops* Wirth & Hale (holotype, *Hale* 20383). 73. *P. elliptica* Wirth & Hale (holotype, *Hale* 20088).

and the ascocarps are more crowded and elliptical than in typical *P. scalpturata.*

5. Phaeographis

43. Phaeographis dendritica (Ach.) Müll. Arg. Flora 65:382. 1882. FIGURE 74
Opegrapha dendritica Ach. Meth. Lich. 31. 1803. Type: Southern Spain (UPS, isotype).

Thallus smooth, continuous. Ascocarps semiemergent, often desquamescent, simple to asteroidly branched, acute, surrounded by a low, narrow thalline border, 1–3 mm. long, about 0.4 mm. wide; disc black, flat; exciple dark brown to black, closed; labia entire, spreading; hymenium 80–120 μ high. Spores 8 per ascus, brown, 6–8 locular, 8–11×26–42 μ.

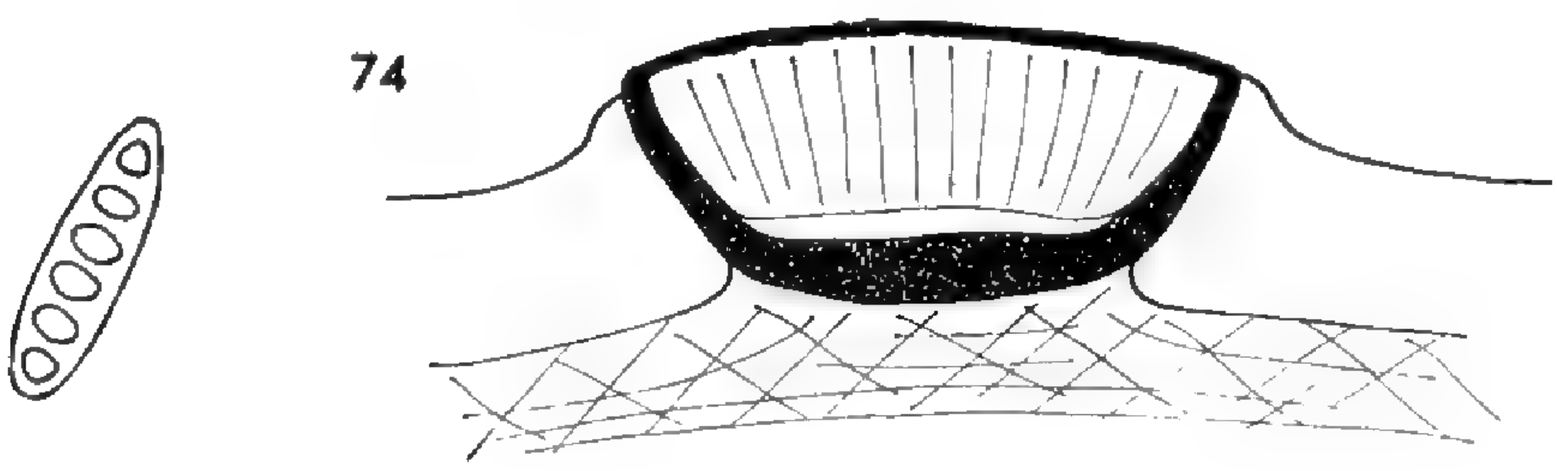


FIGURE 74.—*Phaeographis dendritica* (Ach.) Müll. Arg. (isotype).

Reactions: KOH+ red, norstictic acid.

Specimens examined: Chiapas: West of Tuxtla Gutiérrez, *Hale* 19895 (US). Vera Cruz: Orizaba, *Fr. Müller* (US).

The Mexican specimens are identical in all respects with the isotype. It is altogether possible that the great variability attributed to

P. dendritica may be incorrect and that the numerous subspecific taxa described represent other species.

44. Phaeographis exaltata (Mont. et v. d. Bosch) Müll. Arg. Flora 65:336. 1882. FIGURE 75

Lecanactis exaltata Mont. et v. d. Bosch, Pl. Junghuhn, 4:475. 1855. Type: Java, *Junghuhn* (not seen).

Thallus continuous, smooth to warty. Ascocarps sessile, sparingly branched or unbranched, rotund to lirelline, stout, 0.5–4 mm. long, 0.5–1 mm. wide, often apically rounded, laterally with a very prominent thalline margin much as in *Sarcographa;* disc black, wide; exciple black, closed, thickened below; labia entire, divergent; hymenium inspersed with brown oil droplets, 120–150 μ high. Spores 8 per ascus, 6–10 locular, 8–11×23–32 μ.

Reactions: KOH+ yellow, unknown acid in o-T.

Specimen examined: Chiapas: Lagos de Monte Bello, *Hale* 20394 (US).

This species is one of the numerous transition species between *Sarcographa* and *Phaeographis* and could easily be placed in either genus. The unknown lichen acid is identical with that found in *Graphina virginea, G. triangularis,* etc.

45. Phaeographis sericea (Eschw. in Mart.) Müll. Arg. Flora 71:523. 1888. FIGURE 77

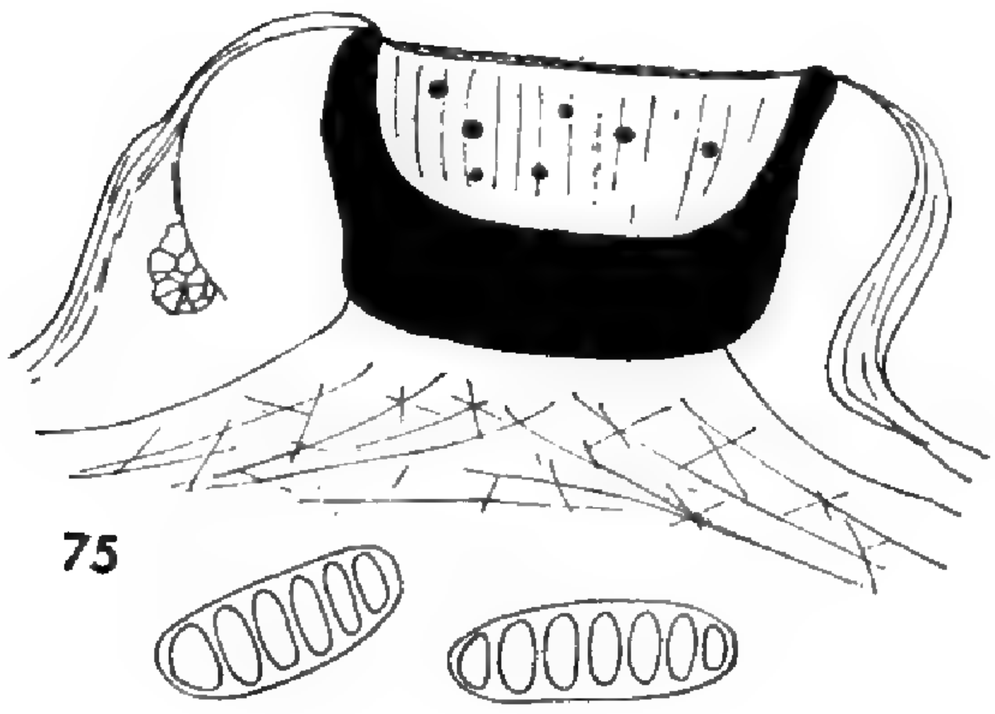
Leiogramma sericeum Eschw. in Mart. Icon. Pl. Crypt. 2:34. 1828. Type: Brazil (not seen).

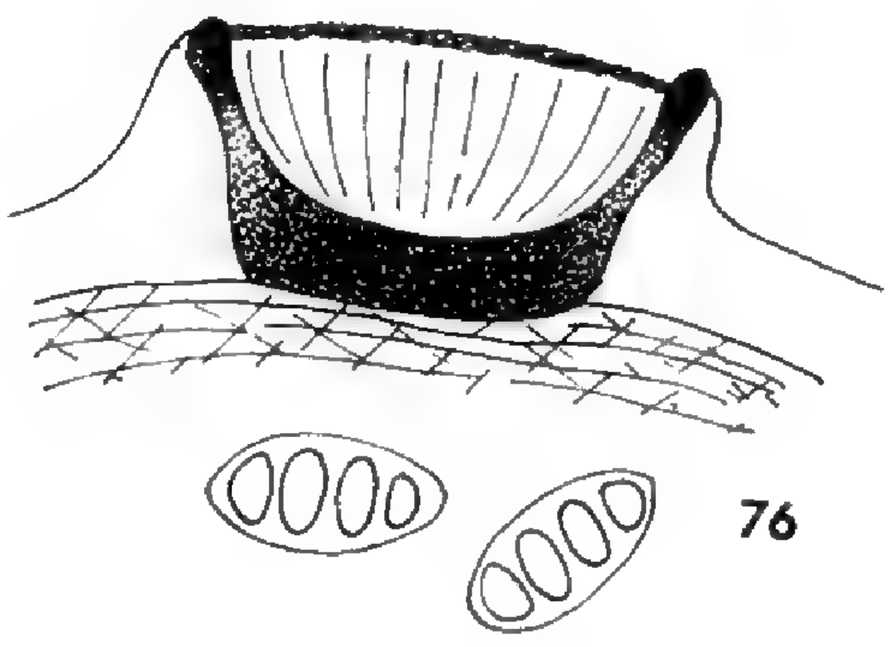
Thallus thin, more or less continuous, smooth. Ascocarps black, often very variable, some lirellae asteroidly branched, immersed, narrow, apically acute, with a mealy, prominent thalline margin, disc black, other lirellae subsessile, lacking a mealy margin, irregularly branched and intricate, apically rounded, disc lightly pruinose, to 0.5 mm. wide; exciple black, closed, thickened below; labia at first convergent, then divergent, entire; hymenium 80–90 μ high. Spores 8 per ascus, 4 locular, 7–8×18–21 μ.

Reactions: KOH+ yellow, P−, o-T−, no acids demonstrated.

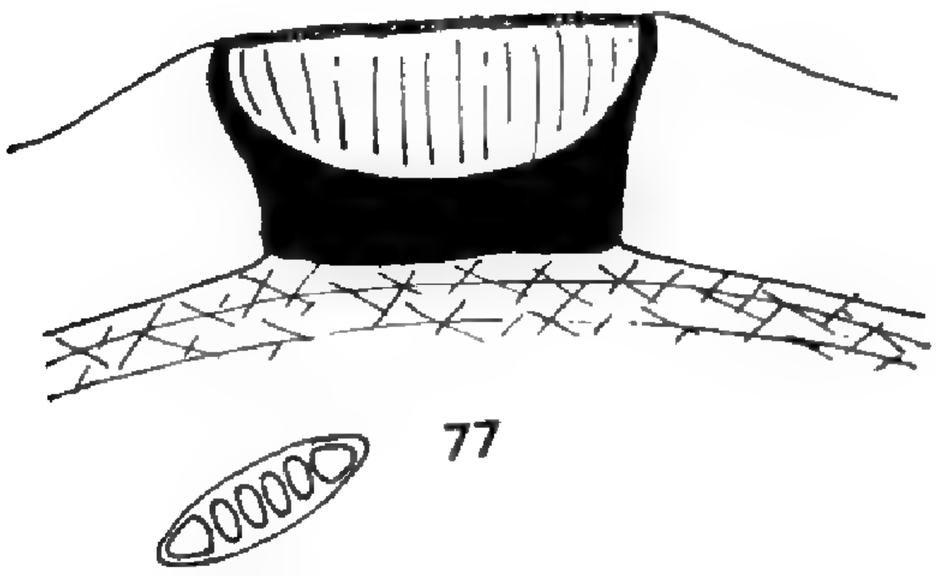
Specimens examined: Chiapas: North of Berriozábal, *Hale* 20107 (S, US). Vera Cruz: East of Córdoba, *Hale* 19727 (US).

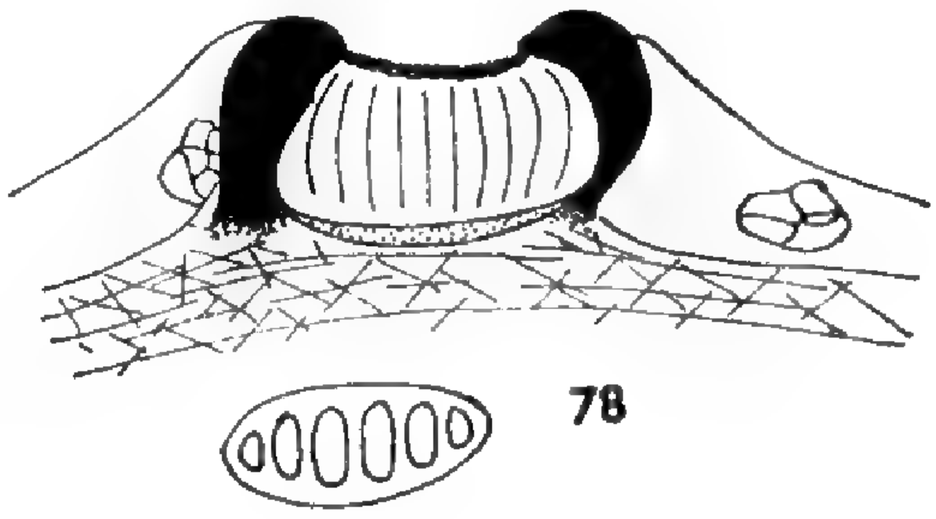
The variation in ascocarp shape in the cited specimens is extremely instructive. Most clusters appear to originate as immersed, radiately branched, acute ascocarps with prominent mealy margins and black discs. Sometimes these "juvenile" forms are simple and unbranched with rotund apices. However, it is not possible to consider these stages as immature, since spores are commonly present, and the "adult" stage is often found interconnected. This later stage lacks the mealy margin, is always subsessile, has lightly pruinose discs and rotund apices, and has an irregular, intricated mode of branching.





FIGURES 75, 76.—75. *Phaeographis exaltata* (Mont. & v. d. Bosch) Müll. Arg. (*Hale* 20394).
76. *P. inusta* (Ach.) Müll. Arg. (isotype, *Kalm*).





FIGURES 77, 78.—77. *Phaeographis sericea* (Eschw. in Mart.) Müll. Arg. (*Hale* 19727).
78. *P. sexloculata* Fink (holotype, *Fink* 1436).

This great variability of form seems to be rather common in those Graphidaceae which have thick walled brown spores with carbonized exciples. In the light of this variation, we should re-examine carefully the species criteria within this group.

There are at least two other species of *Phaeographis* which may well prove to be synonyms of *P. sericea: P. aggregata* Redgr. and *P. substellata* Zahlbr., but we have not yet examined the type specimens.

46. Phaeographis sexloculata Fink, Mycologia 19:215. 1927. FIGURE 78

Holotype: Yauco, Puerto Rico, *Fink* 1436 (MICH).

Thallus smooth, continuous. Ascocarps black, slender, flexuose, semiemergent, unbranched to occasionally branched, 1–3 mm. long; exciple black, open; labia entire, erect or somewhat convergent, but exposing the hymenium; hymenium 65–80 μ high. Spores 8 per ascus, commonly 6 locular, 8–10×18–26 μ.

Reactions: KOH+ yellowish, P—, no microchemical tests made.

Specimen examined: Carmen Island, *Rabenhorst* 25 p.p. (M).

The Mexican material of this species was reported by Kremplehuber (1876, p. 148) as *Graphis* (*Phaeographis*) *leiogrammodes*. However, the holotype of *G. leiogrammodes* has muriform spores.

Excluded or Doubtful Species

47. Graphina sophistica (Nyl.) Müll. Arg. Flora 63:40. 1880.
Graphis sophistica Nyl. Ann. Sci. Nat. Bot. ser. 4, 19:359. 1863. Syntypes: Villeta, Colombia, *Lindig* 876, 902, 2726, 2737 (not seen).

Thallus continuous, smooth. Ascocarps subsessile, sparingly branched or unbranched, black; disc narrow, epruinose; exciple black, open or closed; labia convergent, entire or lightly crenate. Spores 2–4 per ascus, 12–20×35–65 μ.

This species was reported from Monterrey, Mexico, by Müller (1894, p. 92), but we have seen neither this specimen, the type, or any Mexican material referable here.

48. Graphis scripta (L.) Ach. Vet. Akad. Nya Handl. (Stockholm) 145. 1809.
Lichen scriptus L. Sp. Pl. 1140. 1753.

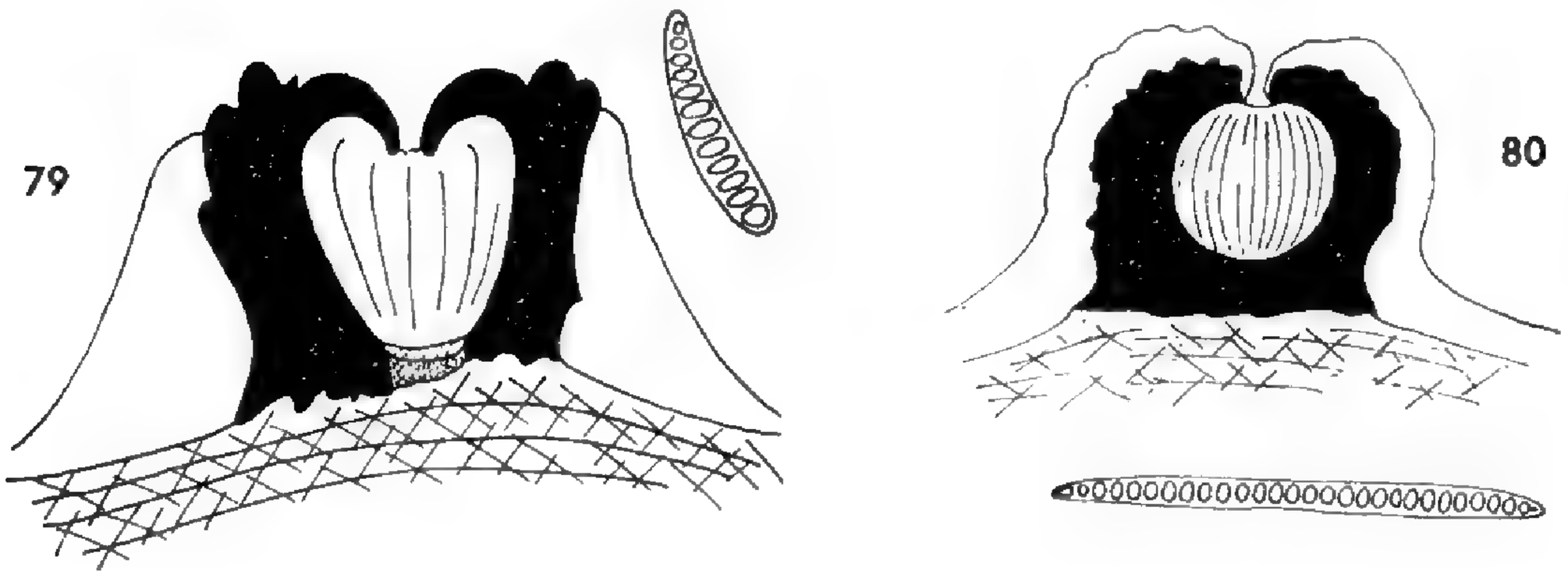
Graphis scripta and a number of closely allied species must be critically examined before any sound taxonomic judgments can be made about this widespread group. Redinger (1935, p. 8) separated *G. tenella* Ach., *G. leptocarpa* Fée, *G. scripta*, *G. lineola* Ach., and *G. pavoniana* Fée on the basis of spore size, degree of ascocarp immersion, and length and branching of the ascocarps. The first three of these four criteria are nearly useless in this group. The isotypes of *G. tenella* Ach. (UPS) have ascocarps with convergent labia which become striate with age. The isotype of *G. lineola* Ach. (UPS) contains a *Melaspilea*, an *Opegrapha* (which conceivably could be a lectotype), and a sterile unidentifiable entity.

Graphis scripta itself can probably be typified through the Dillenian syntype cited by Linnaeus. This would still leave approximately 190 named varieties, forms, etc., listed in Zahlbruckner's Catalog. A critical study of these taxa in addition to numerous related species in *Graphis* and *Phaeographis* will pose a formidable problem for future lichenologists.

49. Graphis striatula (Ach.) Sprengl. Syst. Veg. 4:250. 1827. FIGURE 79
Opegrapha striatula Ach. Syn. Lich. 74. 1814. Type: Guinea (UPS, isotype). Reactions: KOH+ reddish, P−, no microchemical tests made.

Thallus thin, discontinuous. Ascocarps sessile, black, *Opegrapha*-like, straight to slightly flexuose, unbranched, 0.5–2 mm. long, about 0.3 mm. wide; exciple black, usually open, 100 μ high; labia convergent, striate. Spores 8 per ascus, 11–13 locular, 8–10×38–43 μ.

This species was reported from Orizaba, Mexico, by Nylander (1858, p. 381), along with two new varieties, var. *sublaevis* Nyl. and var. *pulverulenta* Nyl. The former variety was described as having branched ascocarps, the latter as having barely striate labia. Müller (1887, p. 35) made the transfer *Graphis duplicata* var. *sublaevis* (Nyl.) Müll. Arg. He distinguished *G. duplicata* from *G. striatula* only by



FIGURES 79, 80.—79. *Graphis striatula* (Ach.) Sprengl. (isotype). 80. *Graphis vermiformis* (Eschw. in Mart.) Nyl. (s. c., FH-Tayl).

the more sessile unbordered ascocarps of the latter. We have not seen any material of these taxa from Mexico.

The isotypes of *G. striatula* and *G. duplicata* actually cannot be separated on the basis of sessile *vs.* nonsessile ascocarps, although they may be maintained by the gross form of the lirellae. In *G. striatula*, they are *Opegrapha*-like, unbranched, nearly straight, and short. In *G. duplicata*, they are elongate, branched, curved and flexuose. It would seem therefore that *G. striatula* var. *sublaevis* is referable to *G. duplicata*, as Müller indicated.

50. Graphis vermiformis (Eschw. in Mart.) Nyl. Flora 41:381. 1858.

FIGURE 80

Graphis illinata var. *vermiformis* Eschw. in Mart. Fl. Bras. 1:83. 1833.
Type: Near Pará, Brazil (not seen).

Thallus thin, continuous, slightly roughened. Ascocarps sessile, unbranched, 1–3 mm. long, 0.5 mm. wide, concolorous with the thallus; exciple black, closed; labia convergent, more or less denticulate or dentate, completely covered by a thalline veil. Spores 8 per ascus, vermiform, 20–25 locular, 7–9×65–75 μ.

This species was reported from Orizaba, Mexico, by Nylander (1858, p. 381), but we have not verified this report. The Guianan specimen on which the above description was based is in the Taylor Herbarium (FH), labeled "Graphis illinita Eschw." and reacts KOH+ brown, P+ brown.

Graphis vermiformis is listed by Zahlbruckner (1923, p. 297) as a synonym of *G. candidata* Nyl. However, Nylander's elevation of var. *vermiformis* to species level antedates the publication of *G. candidata* by 16 years. Hence if the two taxa are identical, *G. vermiformis* has priority. This species is closely related to *Graphis anguilliformis* Tayl., differing in the more slender vermiform spores and completely covered ascocarps.

686–879—63——4

51. Melaspilea lentiginosa (Lyell in Leight.) Müll. Arg. Mem. Soc. Phys. Hist. Nat. Genève 29, No. 8:19. 1887.

Opegrapha lentiginosa Lyell in Leight. Ann. Mag. Nat. Hist. 2, No. 13:211. 1854. Types: New Forest, Hants., *Lyell* (US, isosyntype); St. Leonard's Forest, Sussex, England, *Borrer* (not seen).

This species was reported from Orizaba, Mexico, by Nylander (1858, p. 381) but we have not checked this record. The isosyntype of *Opegrapha lentiginosa*, and all specimens we have seen that were referred here by Redinger (1938, p. 228), are lichen parasites on a *Phaeographis* species.

52. Melaspilea leucinoides Müll. Arg. Bull. Herb. Boiss. 2:92. 1894.

Holotype: Jalisco, Mexico, *Pringle* 216 (G).

This entity is an *Opegrapha*.

53. Melaspilea mesophlebia (Nyl.) Müll. Arg. Hedwigia 34:143. 1895.

Opegrapha mesophlebia Nyl. Sert. Lich. Trop. Singapore et Labuan 42. 1891.

Opegrapha mesophlabia Nyl. Bull. Torrey Bot. Club 19:250. 1892. A sphalm. Holotype: San Luis Potosí, Mexico, *Pringle* 230 (H).

This species also belongs in the genus *Opegrapha*.

54. Melaspilea microphlebia (Nyl.) Zahlbr. Cat. Lich. Univ. 2:279. 1923.

Opegrapha microphlebia Nyl. Bull. Soc. Linn. Norm. 2, no. 3:272. 1869. Type: Guadeloupe, *Husnot* (not seen).

Eckfeldt (1892, p. 250) identified *Pringle* s.n., from Monterrey, Mexico, as *Opegrapha microphlebia* Nyl. We have checked the *Pringle* collection (VT) and found that it is indeed an *Opegrapha*.

55. Phaeographina leiogrammodes (Kremplh.), comb. nov. FIGURE 81

Graphis leiogrammodes Kremplh. Natur. For. Kjöben. Vid. Medd. 5:25. 1873. Holotype: Lagõa Santa, Brazil, *Warming* 22 (M). Reactions: KOH+ reddish, P−, o-T−, no acids demonstrated.

Phaeographis leiogrammodes (Kremplh.) Müll. Arg. Nuov. Giorn. Bot. Ital. 23:397. 1891.

The holotype specimen is undoubtedly a *Phaeographina*, externally quite similar to *P. exilior* (Vain.) Zahlbr. The juvenile spores are transversely 4 locular, as described, but at maturity one or all of the 4 locules become biocellate.

Krempelhuber (1876, p. 148) reported this species from Mexico, but these collections are all referable to *Phaeographis*.

56. Phaeographina scalpturata (Ach.) Müll. Arg. Flora 65:399. 1882. FIGURE 82

Graphis scalpturata Ach. Syn. Lich. 86. 1814. Type: South America (UPS, isotype). Reactions: KOH+ reddish, P−, no microchemical tests made.

Thallus smooth, continuous. Ascocarps barely emergent, flexuose, 2–6 mm. long, about 0.4 mm. wide, apically rounded, often surrounded by a lighter thalline area; disc flat, wide, black or lightly pruinose;

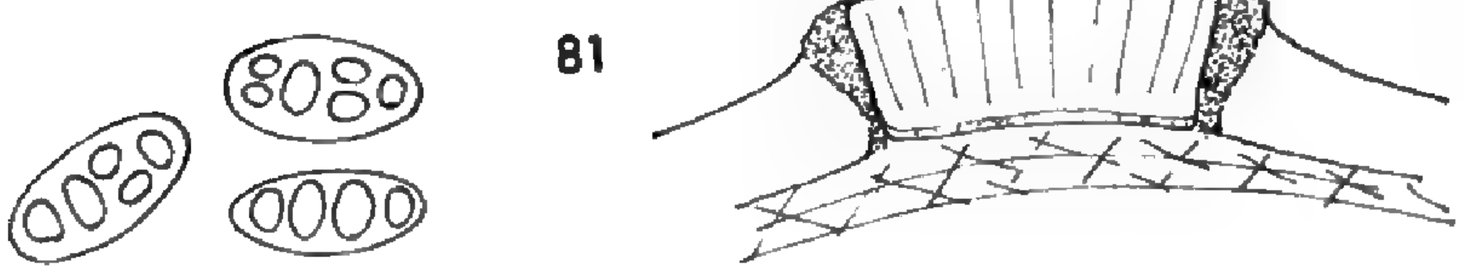


FIGURE 81.—*Phaeographina leiogrammodes* (Kremplh.) Wirth & Hale (holotype, *Warming* 22).

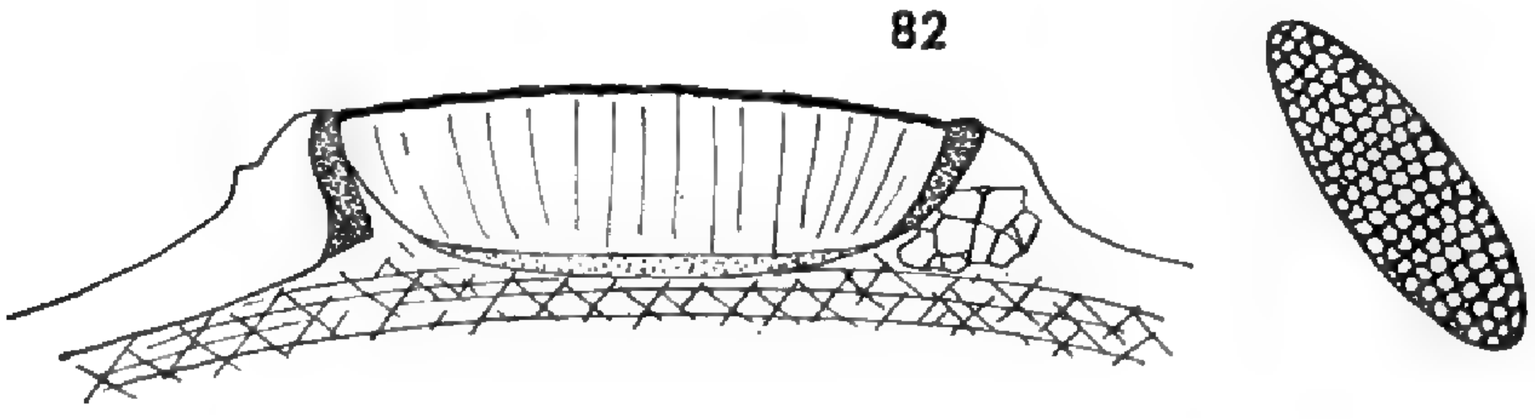


FIGURE 82.—*Phaeographina scalpturata* (Ach.) Müll. Arg. (isotype).

exciple pale brown, open; labia entire, divergent; hymenium clear, 150 μ high. Spores 1 per ascus, densely muriform, 23–26×80–85 μ.

A record from Mexico (*Pringle* 335) reported by Davis (1936) has not been seen. *Phaeographina scalpturata* is evidently a completely misinterpreted species. Many previous workers have mentioned a carbonized exciple and placed the species in section *Eleutheroloma*. Much of the material we have seen under this name, identified by Nylander, Müller, Redinger, etc., has black exciples, huge spores, sessile ascocarps, and prominent thalline margins. This entity, for which we have not been able to determine a specific name, was listed on p. 103 as *Phaeographina* sp. We have examined very few collections, none from Mexico, that can be identified with *P. scalpturata* as here delimited.

57. Phaeographis inusta (Ach.) Müll. Arg. Flora 65:383. 1882. FIGURE 76
Graphis inusta Ach. Syn. Lich. 85. 1814. Type: Canada, *Kalm* (UPS, isotype). Reactions: KOH+ reddish, P−, o-T−, no acids demonstrated.

Thallus continuous, minutely roughened to nitid. Ascocarps semi-emergent, unbranched to sparingly branched, elliptical to lirelline, apically rounded, 0.5–1.2 mm. long, about 0.2 mm. wide, usually without a thalline margin; disc dark brown, slightly concave, wide; exciple red-brown, closed, thickened below; labia entire, divergent, often slightly carbonized; hymenium about 60 μ high. Spores (?6–)8 per ascus, 4 locular, 6–10×16–21 μ.

Nylander's report from Mexico (1858, p. 381) has not been verified. An examination of the isotype of *P. inusta* disclosed that the traditional concept of the species is probably incorrect. *P. inusta* is usually regarded as being much like *P. dendritica*, differing primarily in having an open exciple. However, the authentic material has constantly 4 locular spores and brown closed exciples.

Phaeographis inustoides Fink (holotype: Puerto Rico, *Heller* 4430, MICH) is apparently distinct. It has 5–7 locules per spore, norstictic acid, pale labial apices, and a prominently cellular cortex (chondroid in the sense of Redinger, a fact which throws doubt on his placing this entity as a synonym of *P. punctiformis* (Eschw.) Müll. Arg.).

Type Specimens Examined and Their Chemical Reactions

Graphina

Graphina acharii var. subintegra Zahlbr. [=G. inturgescens (Kremplh. Müll. Arg.]. *Pringle* 5 p.p. (MICH, isosyntype) KOH−, P−.

Graphina acromelaena Müll. Arg. [=G. parilis (Kremplh.) Müll. Arg.]. *Tonduz* s.n. (G, holotype): KOH+ yellow, stictic acid.

Graphina acrophaea Müll. Arg. [=G. parilis (Kremplh.) Müll. Arg.]. *Langlois* 751 (US, isosyntype): KOH+ yellow, stictic acid.

Graphina aibonitensis Fink. *Fink* 2017 (MICH, holotype): KOH+ red, salacinic acid.

Graphina balbisii var. monospora Redgr. *Malme* 494 (S, holotype; FH, isotype): KOH−, P−.

Graphina bipartita Müll. Arg. *Balansa* 1876 (G, holotype): KOH+ red, norstictic acid.

Graphina bothynocarpa Redgr. *Malme* 2464 (S, holotype): KOH−, KC−, P−.

Graphina cinerea Fink. [=G. scolecitis (Tuck.) Fink]. *Fink* 1163 (MICH, holotype): Thallus KOH−, P−; ascocarps KOH+ blackish, P−.

Graphina collatinensis var. lirelliformis Redgr. [=G. confluens (Fée) Müll. Arg.]. *Malme* 84 (S, holotype): norstictic acid.

Graphina corcovadensis Redgr. *Malme* 41 (S, holotype): KOH+ yellow, stictic acid.

Graphina epiglauca Müll. Arg. [=G. confluens (Fée) Müll. Arg.]. *Pittier* s.n. (US, isotype): KOH+ yellow, stictic acid, lichexanthone.

Graphina heteroplacoides Redgr. *Malme* 1227 (S. holotype): KOH+ red, P−, o-T unknown acid.

Graphina incerta Redgr. *Malme* 3644 (S, syntype): KOH−, P−; *Malme* 1890f (S, syntype) [=Graphis (Graphina) leucopepla Tuck.]: P+ red, protocetraric acid.

Graphina interstes Müll. Arg. *Tonduz* s.n. (G. holotype): KOH+ red, o-T unknown acid.

Graphina luridoolivacea Fink. *Fink* 657 (MICH, holotype): KOH+ red, P−, o-T−.

Graphina malmei Redgr. *Malme* 3508 (S, holotype): Thallus KOH− P−; ascocarps cinnabar, KOH+ purple.

Graphina obtectula Müll. Arg. *Tonduz* s.n. (G, holotype): KOH+ yellow, o-T unknown acid.

Graphina olivobrunnea Fink. [=G. scolecitis (Tuck.) Fink]. *Fink* 1224 (MICH, holotype): Thallus KOH−, P−; ascocarps KOH+ purple, P−, o-T−.

Graphina palmeri Zahlbr. *Pringle* 9 (MICH, isotype): KOH+ yellow, o-T unknown acid.

Graphina platycarpa Fink [non G. platycarpa (Eschw. in Mart.) Müll. Arg.] [=G. platycarpina Zahlbr.]. *Fink* 1774 (MICH, holotype): P+ red, protocetraric acid.

Graphina plittii Zahlbr. *Plitt* s.n. (US, BPI, isotypes): KOH+ red, salacinic acid.

Graphina pseudophlyctis var. monospora Redgr. *Malme* 2023, 2177, 3678, 3679 (S, syntypes): KOH−, P—.

Graphina puiggarii Müll. Arg. *Puiggari* 506 (G, holotype): KOH−, P−.

Graphina puiggarii var. corumbensis Redgr. [=G. parilis (Kremplh.) Müll. Arg.]. *Malme* 3639, 3636, 3637 (S, syntypes): KOH+ yellow, stictic acid.

Graphina reniformis var. subastroidea Redgr. *Malme* 3520 (S, holotype): P+ red, protocetraric acid and lichexanthone.

Graphina rimulosa Redgr. *Malme* 1089 (S, holotype): KOH+ reddish, P−.

Graphina riopiedrensis Fink. *Fink* 2167 (MICH, holotype): KOH+ yellowish, stictic acid.

Graphina sulcata Fink. *Fink* 659 (MICH, holotype): KOH+ red, norstictic acid.

Graphina sulcatula var. conglomerata Müll. Arg. *Balansa* 4185a (G, syntype): KOH−, P−.

Graphina triangularis Zahlbr. *Pringle* 17 (MICH, isotype): KOH+ yellow-red, o-T unknown acids.

Graphina vestitoides Fink. *Fink* 1986 (MICH, holotype): KOH−, P−.

Graphis

Graphis abaphoides Nyl. (Graphina abaphoides (Nyl.) Müll. Arg.). *Calkins* 134 (US, isosyntype): KOH+ yellowish, P+ red, protocetraric acid and an unknown acid.

Graphis adpressa Vain. *Vainio* 1289 (TUR, holotype): KOH−, P−.

Graphis afzelii Ach. (UPS, isotype): Ascocarps KOH−, P−, C+ red, lecanoric acid.

Graphis albescens Vain. *Vainio* s. n. (TUR, holotype): KOH+ yellow, stictic acid.

Graphis albida Fink. *Fink* 1777 (MICH, holotype): P+ red, protocetraric acid.

Graphis albostriata Vain. [=Graphina albostriata (Vain.) Zahlbr.]. *Vainio* 1538 (TUR, holotype): KOH+ yellow, P−, o-T unknown acid.

Graphis anguinaeformis Vain. [=Graphina anguinaeformis (Vain.) Zahlbr.]. *Vainio* 274 (TUR holotype): KOH−, P−.

Graphis arecae Vain. *Merrill* 6724 US, isotype): KOH+ yellow, stictic acid.

Graphis atroalba Vain. non Kremplh. (=G. afzelii Ach.). *Vainio* 189 (TUR, holotype): Ascocarps KOH−, C+ red.

Graphis brachycarpa Vain. *Vainio* 1092 (TUR, holotype): KOH−, P−.

Graphis caesiella Vain. *Vainio* 45 (TUR, holotype): KOH+ red, norstictic acid.

Graphis caesioglauca Redgr. *Malme* 1526 (S, holotype): KOH− P−.

Graphis carassensis Vain. [=Graphina carassensis (Vain.) Zahlbr.]. *Vainio* 1467 (TUR, holotype): KOH+ reddish, P−, no acids demonstrated.

Graphis cladophora Vain. [=Graphina cladophora (Vain.) Zahlbr.]. *Merrill* 7990 (US, isotype): KOH+ red, norstictic acid.

Graphis collosporella Vain. [=Graphina collosporella (Vain.) Zahlbr.]. *Thaxter* 9, 10 (FH, syntypes): KOH+ yellowish, unknown acid.

Graphis compulsa Kremplh. [=G. desquamescens Fée]. *Glaziou* 5082 (M, holotype): KOH+ red, norstictic acid.

Graphis dehiscens Vain. [=Graphina!]. *Vainio* 306 (TUR, holotype): KOH+?, P−.

Graphis diaphoroides Müll. Arg. *Lahm* 91 (US, isosyntype): KOH+ red, norstictic acid.

Graphis dimidiata Vain. [=Graphina dimidiata (Vain.) Zahlbr.]. *Vainio* 332 (TUR, holotype): KOH−, P−.

Graphis diorygmatoides Vain. [=Graphina diorygmatoides (Vain.) Zahlbr.]. *Merrill* 8515 (US, isotype): KOH+ red, norstictic acid.

Graphis elongata Vain. [=Graphina elongata (Vain.) Zahlbr.]. *Vainio* 782 (TUR, holotype): KOH+ red, norstictic acid.

Graphis endoxantha Nyl. *Pancher* s.n. (H, holotype): KOH+ reddish, P−.

Graphis eugeniae Vain. *Whitford* 1087 (US, isosyntype): KOH+ red, salacinic acid.

Graphis floridana Tuck. (US, isotype): KOH+ red, norstictic acid.

Graphis granulocarpa Vain. *Vainio* 3680 (TUR, holotype): KOH+ reddish, P−.

Graphis hiascens var. clausior Vain. [=Graphina hiascens var. clausior (Vain.) Zahlbr.]. *Ramos & Edano* 29548 (US, isotype): KOH+ yellow, stictic acid.

Graphis hololeucoides Nyl. [=Graphina hololeucoides (Nyl.) Müll. Arg.]. *Ghiesbreght* s.n. (H, isotype): Ascocarps KOH+ faint yellowish, P+.

Graphis humilis Vain. *Merrill* 9067 (US, isotype): KOH+ red, o-T unknown acid.

Graphis illota Müll. Arg. *Ule* 273 (G, holotype): KOH−, P−.

Graphis immersa Fink. *Fink* 1613 (MICH, holotype): KOH−, P+.

Graphis includens Vain. [=Graphina!]. *Vainio* 765 (TUR, holotype): KOH+ reddish, P−, o-T−.

Graphis inidita var. pularensis Vain. [=Graphina inidita var. pularensis (Vain.) Zahlbr.]. *Ramos* 19446 (US, isotype): KOH+ yellow, stictic acid.

Graphis isidiosa Vain. [=Phaeographina isidiosa (Vain.) Zahlbr.]. *Merrill* 6647 (US, isosyntype): KOH+ red, norstictic acid.

Graphis leucopepla Tuck. [=Graphina!]. *Wilson* 56 (FH, holotype): Thallus KOH−, P−; ascocarps KOH−, P+.

Graphis lutescens Kremplh. non Fée [=Phaeographina lutescens (Kremplh.) Zahlbr.]. *Glaziou* 3374 (M, holotype): KOH+ red, norstictic acid.

Graphis macgregorii Vain. [=Graphina hiascens (Fée) Müll. Arg.]. *MacGregor* (607 US, isotype): KOH+ red, norstictic acid.

Graphis macrospora Kremplh. [=Graphina confluens (Fée) Müll. Arg.]. *Glaziou* 3379 (M, syntype): KOH+ yellow, stictic acid, lichexanthone, a fatty substance.

Graphis miniata Redgr. [=Phaeographina chrysocarpa (Raddi) Redgr.]. *Mosén* 3145, 3313, 3577 (S, syntypes): Thallus KOH−, P−; ascocarps KOH+ purple.

Graphis olivacea Redgr. *Malme* 2267 (S, holotype): KOH+ reddish, P−.

Graphis orientalis Vain. [=Graphina hiascens (Fée) Müll. Arg.]. *Merrill* 6716 (US, isotype): KOH+ red, norstictic acid.

Graphis oscitans Tuck. [=Phaeographina oscitans (Tuck.) Zahlbr.]. *Mann*, s.n. (US, isotype): KOH+ yellow, stictic acid.

Graphis peralbida Nyl. [=Graphina bipartita Müll. Arg.]. *Pringle* 222 (H, holotype; FH, VT, isotypes): KOH+ red, norstictic acid.

Graphis phaeospora Vain. [=Graphina inturgescens (Kremplh.) Müll. Arg.]. *Vainio* 682 (TUR, holotype): KOH−, P−.

Graphis pseudosophistica Vain. [=Graphina pseudosophistica (Vain.) Zahlbr.]. *Vainio* 757 (TUR, syntype): KOH+ reddish, P−, o-T unknown acid; *Vainio* 1003 (TUR, syntype): KOH+ red, P−; *Vainio* 1404 (TUR, syntype): KOH−, P−.

Graphis rimulosa var. lignicola Fink. *Fink* 1873 (MICH, holotype): KOH−, P−.

Graphis sitiana Vain. *Vainio* 533 (TUR, holotype): KOH−, P−.

Graphis subamylacea Zahlbr. *Pringle* 24 (MICH, isotype): KOH+ yellow, stictic acid.

Graphis subcabbalistica Vain. [=Graphina!]. *Vainio* 1246 (TUR, holotype): KOH+ reddish, P−.

Graphis subducta Vain. [=Graphina parilis (Kremplh.) Müll. Arg.]. *Merrill* 8576 (US, isotype): KOH+ yellow, stictic acid.

Graphis subelegans Nyl. [=G. endoxantha Nyl.]. *Pringle* 162 (H, holotype): KOH+ red, P−.

Graphis subparilis Nyl. *Calkins* s.n. (US, isotype): Thallus KOH−, P−; ascocarps KOH+ purple.

Graphis subserpentina Nyl. [=Graphina hiascens (Fée) Müll. Arg.]. *Gardner* s.n. (US, isotype): KOH+ red, norstictic acid.

Graphis tongloensis Vain. *Merrill* 7985 (US, isotype): KOH−, P−.

Graphis tumidella Fink. *Fink* 1737 (MICH, holotype): KOH−, P−.

Graphis turbulenta Nyl. *Calkins* s.n. (US, isotype): KOH+ red, norstictic acid.

Graphis virens Müll. Arg. *Ule* 275 (G, holotype): KOH+ red, P−, o-T−.

Graphis yaucoensis Fink [=G. caesiella Vain.]. *Fink* 1691 (MICH, holotype): KOH+ red, norstictic acid.

Medusulina

Medusulina texana Müll. Arg. *Eckfeldt* 56A (G, holotype): KOH+ yellow, stictic acid.

Opegrapha

Opegrapha dendritica Ach. [=Phaeographis dendritica (Ach.) Müll. Arg.]. (UPS, isotype): KOH+ red, norstictic acid.

Phaeographina

Phaeographina caesiopruinosa var. abbreviata Redgr. *Malme* 1888, 1492, 1562 (S, syntypes): KOH+ red, P−, o-T−.

Phaeographina difformis Fink. *Fink* 1874 (MICH, holotype): KOH−, P−.

Phaeographina epruinosa Redgr. [=P. explicans Fink in Hedrick]. *Malme* 3662 (S, holotype): KOH+ yellow-red, o-T−.

Phaeographina myriogloena Müll. Arg. *Leprieur* 196 (G, holotype): KOH+ red, P−, o-T−.

Phaeographina oxalifera Redgr. *Malme* 3664 (S, syntype): KOH+ red, norstictic acid.

Phaeographina rhodoplaca Müll. Arg. *Tonduz* s.n. (G, holotype): KOH−, P−.

Phaeographis

Phaeographis astroidea Müll. Arg. [=Graphis!]. *Tonduz* s.n. (G, holotype): KOH+ reddish, P−.

Phaeographis cerviculata Redgr. [=Graphina!]. *Malme* 3531 (S, holotype): KOH+ reddish, P−.

Phaeographis inustioides Fink. *Heller* 4430 (MICH, holotype): KOH+ red, norstictic acid and an unknown acid.

Phaeographis pezizoidea var. pruinosa Redgr. *Malme* 2586C, 2030 (S, syntypes): KOH+ red, norstictic acid.

Phaeographis praestans Müll. Arg. [=Graphis!]. *Tonduz* s.n. (G, holotype): KOH−, P−.

Phaeographis radiatoramosa Redgr. *Mosén* 3578 (S, holotype): KOH+ red, norstictic acid.

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SUBGENUS PARMELIA

By MASON E. HALE, JR., and SYO KUROKAWA

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STUDIES ON PARMELIA SUBGENUS PARMELIA

By Mason E. Hale, Jr., and Syo Kurokawa

Introduction

At least 250 distinct species, most of which occur in the tropics, are included in *Parmelia* subgenus *Parmelia*. They are generally characterized by lobes that are narrow (0.5–4.0 mm. wide), sublinear to subirregular, and often apically truncate. The apothecia are adnate and usually imperforate, and there are rhizines over all or most of the lower surface. This broadly delimited group has usually been called section *Hypotrachyna* Vain., but we propose to recognize it as a subgenus, subgenus *Parmelia*, typified by *P. saxatilis* (L.) Ach.

Subgenus *Parmelia* is coordinate with subgenus *Amphigymnia* (Vain.) Dodge, the broad-lobed Parmelias, and subgenus *Xanthoparmelia* (Vain.) Hale, comb. nov., based on section *Xanthoparmelia* Vain. (1890, p. 60), with *Parmelia conspersa* (Ach.) Ach. as the type species. The Xanthoparmelias are similar in configuration to many species in subgenus *Parmelia*, but they differ in being saxicolous, always containing usnic acid, and having simple rhizines. The brown Parmelias (sections *Melanoparmelia* Zahlbr., *Vainioellae* Gyel., and *Olivascentes* (Hue) Hillm.) are excluded from subgenus *Parmelia*, although we have not yet decided on their exact position in the genus.

In the course of preparing a world monograph of subgenus *Parmelia*, we have examined the types of most of the described species and reevaluated the subgeneric classification. This preliminary study will present the outlines of a new sectional classification, descriptions of 52 new species, 2 new combinations, and 4 new names, and preliminary keys to the species in the major sections. A final monograph must await more extensive study of general herbarium material as well as field work, since many species are still known only from their type localities.

This study has been made possible by the prompt and generous cooperation of the curators and directors of museums and university herbaria in lending type specimens and other valuable collections and in rendering assistance and providing facilities for study during visits. They include Dr. Sten Ahlner (Naturhistoriska Riksmuseet, Stock-

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Drs. G. Degelius and D. D. Awasthi (abbreviated DEGEL and AWAS respectively in the list of species) have kindly sent us their valuable private collections. Dr. Z. Chernohorský arranged for loans of Gyelnik's collections and kindly provided facilities for study in Prague. Mr. M. Wirth assisted in the early work of chemical testing. Drs. Rolf Santesson and Ove Almborn have kindly read various parts of the manuscript and given invaluable aid in problems of sectional classification.

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Morphological Characters

The following are the more important morphological characters that we have found in subgenus *Parmelia*. Some of them have been overlooked or poorly understood by previous workers and will be discussed in detail.

1. Rhizines: Are produced more or less uniformly over the entire lower surface in the majority of species. Certain species with subrotund subirregular lobes, however, may have a narrow though distinct bare or papillate zone around the margins. Three major types of rhizines may be distinguished: simple and unbranched or rarely

sparsely furcate; dichotomously and usually richly branched; and squarrosely branched (fig. 1). Branching of the rhizines has proved

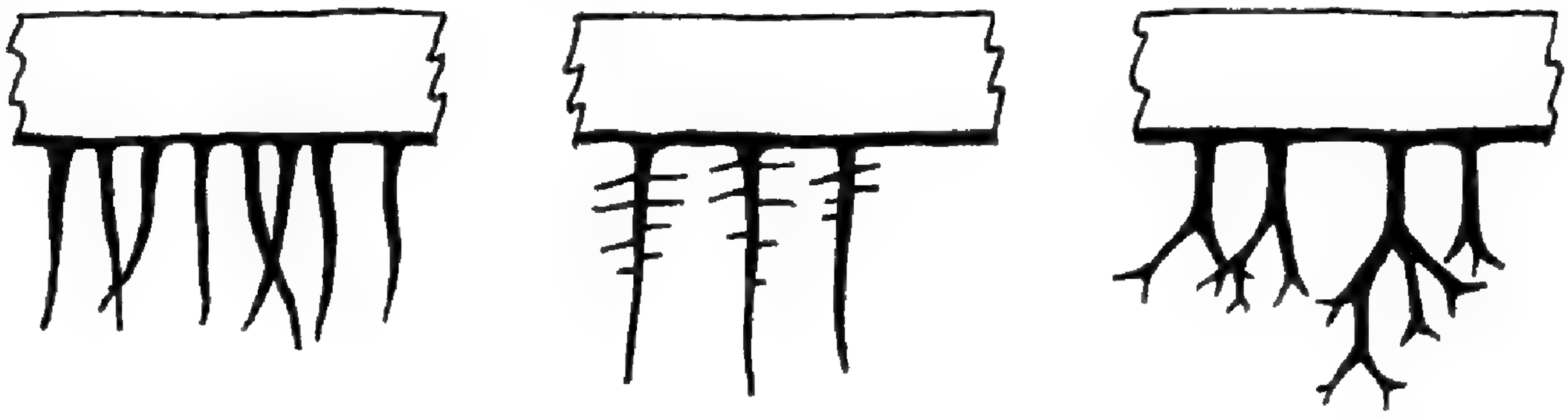

FIGURE 1.—Schematic drawings of the three types of rhizines: Simple, squarrosely branched, and dichotomously branched (left to right).

to be one of the most important characters on which our proposed sectional classification is based.

2. Cilia: Two types of ciliate outgrowths occur on the margins of lobes, simple cilia and bulbate cilia. Simple cilia, comparable to those known in *Anaptychia* or *Cetraria*, occur in at least 34 species of subgenus *Parmelia* (pl. 1). These same species usually have a black lower surface and simple rhizines (e.g., *P. dissecta* Nyl. and *P. tiliacea* (Hoffm.) Ach.). Bulbate cilia differ from simple cilia in having a conspicuously inflated base. This structure (pl. 1) is known in some 45 species, all of them tropical. It has not been consistently recognized by lichenologists, although commemorated in names such as *P. circumnodata* Nyl. Bulbate species may have branched or unbranched rhizines and a pale or black lower surface. Bulbate cilia may merely be modifications of simple cilia, but they are distributed around the lobes with much greater regularity. Chemical data (table 1) indicate that simple-ciliate and bulbate-ciliate species are far more closely related to each other than to any other groups in the subgenus. Both types of cilia are probably related to rhizines and, as in the case of rhizines, are of very great importance in subgeneric classification.

3. Lobules: These structures have usually been confused with isidia. They apparently originate as isidia but soon begin to flatten and grow horizontally (cf. *Parmelia ensifolia*, pl. 7). At maturity they are more or less dorsiventral and often ciliate. Lobules are rather rare and best seen in *P. culmigena* Zahlbr., *P. digitata* Lynge, *P. horrescens* Tayl., or *P. ensifolia* Kurokawa.

4. Pustules: Are coarse papillar outgrowths from the upper cortex. They are extremely fragile and seem to lack the thalloid structure of isidia. They may remain intact, as in *P. dactylifera* Vain., or at length erupt or burst open apically and form dense pustular masses, with little or no tendency to become sorediate (pl. 1). If coarse

soredia form, they are not so dense as to obscure the basic pustular structure. Typically pustulate species include *P. aurulenta* Tuck., *P. endochlora* Leight., *P. formosana* Zahlbr., and *P. spumosa* Asah.

5. Maculae: Are submacroscopic white dots uniformly scattered in the upper cortex. They are apparently caused by irregular clumping of algal colonies in the gonidial layer. They are at times difficult to recognize, and most lichenologists have in fact overlooked them. Maculae are nevertheless important, especially at the species level. They occur in such well-known species as *P. laevigata* (Sm.) Ach. and *P. tiliacea* (Hoffm.) Ach.

6. Pseudocyphellae: Here we refer to actual pores in the upper cortex. There are apparently two different kinds. One is found in species related to *P. borreri* (Sm.) Turn., where the pores are distinctly orbicular or elliptical and scattered irregularly in the upper cortex (pl. 1). They are correlated with the presence of simple rhizines and P− acids (gyrophoric acid, lecanoric acid, and fatty acids). A second type of pore is found in species related to *P. saxatilis* (L.) Ach., where the pores are angular or effigurate and are arranged in more or less definite patterns on the cortex and margins of lobes (pl. 1). These species usually contain a P+ acid (protocetraric or salacinic acid) and have a black lower surface with squarrosely branched rhizines.

7. Reticulation: The upper cortex of a small group of species related to *P. reticulata* Tayl. is finely reticulately maculate and fissured (pl. 1). Initially the cortex is maculate to the margins of the lobes and at maturity actual fissuring usually occurs. Many species of *Parmelia* are irregularly or more or less reticulately cracked on older lobes, but young lobes lack any reticulation. Reticulate species always have a black lower surface and simple to squarrosely branched rhizines.

8. Isidia and soredia: These two characters are well known to lichenologists through the work of Du Rietz (1924a) and require no further discussion here. They are valuable species characters in *Parmelia* but have no value at the sectional level.

9. Apothecia: These characters offer little basis for classification in subgenus *Parmelia*. Spores are uniformly small, generally only 6–18 μ in length, and attain a length of 30 μ in only a few species such as *P. leucopis* Krempl., *P. mutata* Vain., and *P. versiformis* Krempl. Except for *P. cetrata* Ach., *P. homotoma* Nyl., and *P. reticulata* Tayl., the apothecial disc is never perforate. There is little significant variation in degree of adnation on the thallus, except in such unusual pedicellate species as *P. peruviana* Nyl. Coronate exciples and basal retrorse rhizines are often found on the apothecia of species with

bulbate cilia. *Parmelia carporrhizans* Tayl., a ciliate species, is densely rhizinate at the base of the apothecia.

10. Anatomy: The internal anatomy is for the most part uniform. The total thickness of the thallus varies from about 60 μ to 250 μ; the cortex is often thinner and more fragile than in subgenus *Amphigymnia*. Peculiar moniliform cells are found in the medulla of *P. galbina* Ach., *P. obsessa* Ach., and *P. metarevoluta* Asah., three closely related species (cf. Asahina, 1952, p. 98). Future workers may place greater reliance on internal characters, but for the time being this approach seems unrewarding.

Chemical Characters

The taxonomy of subgenus *Parmelia* cannot be studied fully without the use of chemical tests. This does not imply that we are accepting or deliberately describing so-called "chemical species." Anyone who works with a genus such as *Parmelia*, which has a wide

TABLE 1.—*Number of species in the various sections and subsections containing 19 important chemical substances.*

	Section Parmelia		Section Irregulares	Section Imbricaria		Section Cyclochella	Section Hypotrachyna
	Subsection Parmelia	Subsection Simplices		Subsection Bicornutae	Subsection Imbricaria		
Number of species	30	25	10	46	33	46	83
Gyrophoric acid	—	5	—	7	4	—	6
Lecanoric acid	—	10	—	3	4	2	* [5]
Salacinic acid	28	—	7	10	4	3	8
Stictic acid	—	—	—	2	2	5	1
Norstictic acid	—	—	—	4	2	—	5
Protocetraric acid	2	—	—	3	1	12	15
Usnic acid	—	—	—	18	1	9	12
Rhodophyscin	—	—	—	—	—	3	9
K— pigments	—	—	—	—	11	5	5
Olivetoric acid	—	—	—	—	—	—	4
Cryptoclorophaeic acid	—	—	1	—	—	—	1
Evernic acid	—	—	—	—	—	1	5
Divaricatic acid	—	—	—	—	—	8	—
Perlatolic acid	—	—	—	—	—	1	—
Alectoronic acid	—	—	—	—	—	—	7
Barbatic acid	—	—	—	—	—	1	11
Lichexanthone	—	—	—	—	—	—	7
KC+ unknown ("livida")	—	—	—	—	—	1	5

* Lecanoric acid in section Hypotrachyna is an accessory component with evernic acid.

variety of color tests and chemical constituents, soon realizes that the lichen acids are absolutley indispensable aids in species identification. We have tested all specimens with the usual microchemical methods of Asahina and Shibata (1954). Detailed discussions of problematic or unidentified substances encountered will be delayed until a final monograph is completed. In the meantime, however, we have prepared a preliminary table showing the number of species within each section or subsection containing each of 19 identifiable lichen substances (table 1). Certain noteworthy features of this table will be discussed below under the various sectional headings.

The color of the thallus and medulla is described for many of the species according to Ridgway's Color Standards and Color Nomenclature (1912); such colors are indicated by the notation R in parentheses.

Subgeneric Classification

A classification for subgenus *Parmelia* is based on results from our own morphological and chemical studies and on reviews of previously proposed classifications, especially those of Vainio (1890, 1923), Gyelnik (1932), and Asahina (1952).

1. Section *Parmelia*
   - Subsection *Parmelia*
   - Subsection *Simplices* Hale & Kurokawa
2. Section *Irregulares* (Vain.) Vain.
3. Section *Imbricaria* (Schreb.) Fr.
   - Subsection *Imbricaria*
   - Subsection *Bicornutae* (Lynge) Hale & Kurokawa
     - Series *Bicornutae*
     - Series *Relicinae* Hale & Kurokawa
4. Section *Cyclocheila* (Vain.) Rãs.
5. Section *Hypotrachyna* Vain.

Typification, descriptions, and discussions of these taxa are presented below under appropriate sectional headings. Keys to species in the major sections are included whenever possible in order to show the relationships of the new species to those already known. The keys do not include a small number of rare problematic species that have not yet been characterized. It is anticipated of course that more new species and revisions of names will be made in the final monograph. It should be emphasized that all species names in the keys are based on the actual study of holotype or lectotype specimens.

Key to Sections

1. Cortex pseudocyphellate, with or without effigurate maculae; rhizines simple or squarrose . . . . . 1. Section **Parmelia** (p. 127)

1. Thallus lacking pseudocyphellae; rhizines simple, dichotomously or squarrosely branched.
   2. Lobes more or less rotund; upper cortex uniformly reticulately maculate or fissured to the margin . . . 2. Section **Irregulares** (Vain.) Vain. (p. 129)
   2. Lobes sublinear and truncate to subrotund; upper cortex continuous, fissured only on older lobes.
      3. Cilia or bulbate cilia present on margins of lobes.
         3. Section **Imbricaria** (Schreb.) Fr. (p. 130)
      3. Cilia absent.
         4. Rhizines simple . . . . . 4. Section **Cyclocheila** (Vain.) Räs. (p. 147)
         4. Rhizines dichotomously branched.
            5. Section **Hypotrachyna** Vain. (p. 159)

Subgenus *Parmelia*

Type species: *Parmelia saxatilis* (L.) Ach.

Thallus appressed to adnate, rarely subascending; lobes sublinear to subirregular, rarely broad and rotund, the margins entire and smooth, ciliate, or bulbate-ciliate; undersurface black or brown, uniformly rhizinate to the margins, or, in species with rotund lobes, with a narrow bare or papillate zone, the rhizines simple and unbranched, dichotomously branched, or squarrosely branched. Apothecia more or less adnate, rarely pedicellate, the disc imperforate (except in section *Irregulares*); spores simple, suborbicular to ellipsoid, usually less than 20 μ long.

Parmelia has been proposed as a nomen genericum conservandum with *P. saxatilis* (L.) Ach. as the lectotype species (cf. International Code of Botanical Nomenclature, p. 220, 1961). This has been the unanimous choice as a lectotype for the genus (cf. Dodge, 1959), and we see no objections to it. *Parmelia saxatilis* is therefore the type of subgenus and section *Parmelia*.

1. Section *Parmelia*

Thallus adnate; lobes sublinear, rarely subirregular and subrotund; upper cortex pseudocyphellate, with or without effigurate maculae; lower surface black or brown, the rhizines simple or squarrosely branched.

Imshaug (1957) placed section *Hypotrachyna* Vain. in synonymy under section *Parmelia*. As will be shown below, Vainio's section is based on *P. brasiliana* Nyl., a tropical species with dichotomously branched rhizines and no pseudocyphellae.

As we previously indicated, there are two quite distinct types of pseudocyphellae in this section, one typically elliptical and correlated

with simple rhizines and the other effigurate-maculate and correlated with squarrosely branched rhizines. They are best treated as two subsections, *Parmelia* and *Simplices*, as follows:

Subsection *Parmelia*

Section *Hypotrachyna* subsection *Myeloleuca* Asah. (1952, p. 24). Lectotype: *P. saxatilis* (L.) Ach.

Upper cortex with effigurate maculae; lower surface black, the rhizines squarrosely branched or simple.

Asahina's subsection *Myeloleuca* included all species of subgenus *Parmelia* lacking medullary pigments. We feel that the most suitable choice of a lectotype for this extremely broad subsection would be *P. saxatilis*. According to the International Code of Botanical Nomenclature (Art. 22), the rule of tautonomy applies only to the subgeneric and sectional ranks. Notwithstanding, we prefer to retain the spirit of the Code and use *Parmelia* as a subsectional epithet as well, even though Asahina's subsection *Myeloleuca* is validly published and synonymous.

As we have delimited this subsection, it contains about 30 species. The upper cortex is often ridged with the effigurate pseudocyphellae forming patterns along the ridges (cf. pl. 1, fig. 4). As far as is known, all species contain salacinic acid, except *P. insensitiva* (Magn.) Anders. and *P. pseudosulcata* Gyel., which contain protocetraric acid. Most of the species are confined to montane or subboreal areas in the Northern and Southern Hemispheres, with the greatest abundance in eastern Asia, where at least 15 species have been reported. Most of the Asian species have been summarized by Asahina (1952). There is a small group of Australian species, including *P. tenuirima* Tayl. and *P. signata* Nyl., which have not yet been fully investigated. The common American and European species *P. fraudans* Nyl., *P. omphalodes* (L.) Ach., *P. saxatilis* (L.) Ach., and *P. sulcata* Tayl. are well known.

Subsection *Simplices* Hale & Kurokawa, subsect. nov.

Thallus superne pseudocyphellatus, pseudocyphellis suborbicularibus vel ovalibus, subtus niger vel pallide castaneus, rhizinis simplicibus.

Type species: *Parmelia borreri* (Sm.) Turn.

This subsection contains at least 25 species, but their taxonomy has not yet been completely worked out. They are found commonly in savannas or dry temperate forests. The pseudocyphellae are similar to those of *P. cetrarioides* (Duby) Nyl., an *Amphigymnia* species. The rhizines are always simple and quite long. The chemistry is extremely simple, the medulla reacting P−, C+ rose or red (gyrophor-

ic or lecanoric acids), or C— (fatty acids). There is very strong correlation between the color of the lower surface and chemical constitution. All species with lecanoric acid, including the well-known *P. subrudecta* Nyl. (*P. dubia* (Wulf.) Schaer.) and *P. rudecta* Ach., have a pale brown lower surface; and all species with gyrophoric acid, such as *P. borreri* (Sm.) Turn. (*P. pseudoborreri* Asah.) and *P. borrerina* Nyl., have a jet-black lower surface. Those with fatty acids have either a pale (e.g., *P. bolliana* Müll. Arg. and *P. canaliculata* Lynge) or a black lower surface (e.g., *P. appalachensis* Culb. and *P. microsticta* Müll. Arg.) (cf. Culberson, 1962).

2. Section *Irregulares* (Vain.) Vain. (1923, p. 34)

Section *Hypotrachyna* * *Irregularis* Vain. (1890, p. 38).
Section *Reticulatae* Du Rietz (1924b, p. 331).
Lectotype species: *Parmelia reticulata* Tayl.
Section *Hypotrachyna* subsection *Irregulares* (Vain.) Gyel. (1932, p. 224).
Section *Hypotrachyna* subsection *Irregulares* (Vain.) Hillm. (1934, p. 188).
Superfluous combination.

Type species: *Parmelia cetrata* Ach.

Thallus loosely adnate; lobes subirregular, usually broad and rotund; upper cortex reticulately maculate and at maturity reticulately fissured to the margins; lower surface black, the rhizines simple or at maturity squarrosely branched. Apothecia more or less substipitate, the disc perforate or imperforate,

Vainio first proposed *Irregulares* in 1890 as a group name under section *Hypotrachyna* without a designated rank. The obvious lectotype is *Parmelia cetrata* Ach. He proposed two other groups of equivalent rank, *Cyclocheila* (lectotype *P. amazonica* Nyl.) and *Sublinearis* (lectotype *P. brasiliana* Nyl.). These three groups were separated by subtle and overlapping differences in lobe configuration and presence of rhizines, papillae, or a narrow bare zone below along the margins. No lichenologist has successfully employed this classification and most recent workers in fact have rejected it (cf. Asahina, 1952; Maas Geesteranus,1947).

Almost all lichenologists except Räsänen (1943), however, have overlooked the fact that Vainio radically revised his own classification in a study of Philippine lichens (1923). He eliminated section *Hypotrachyna* and proposed in its place two sections, section *Irregulares* (including the former *Cyclocheila* and *Irregularis*) and section *Sublineares*. This realignment more or less successfully circumvented the difficulties of his former classification by recognizing only two general types of lobe configuration, subirregular and apically rotund and sublinear and truncate.

Du Rietz' section *Reticulatae* was set up parallel with section *Hypotrachyna* Vain. and section *Amphigymnia* Vain. Du Rietz based

the section not only on *P. cetrata* and *P. reticulata* but also on *P. perforata* (Jacq.) Ach., which is heavily maculate but lacks reticulate fissures. If *P. perforata* is excluded and placed in subgenus *Amphigymnia*, section *Reticulatae* corresponds exactly with section *Irregulares*.

This small section is close to *Amphigymnia* in lobation, but the lower surface is usually rhizinate or papillate to the margins. Furthermore, the rhizines are squarrosely branched at maturity, whereas the rhizines of *Amphigymnia* species are always simple and often sparse. There are about ten species in section *Irregulares*, some very widely distributed in temperate and subtropical areas. The commonly collected species are *P. balansae* Müll. Arg., *P. cetrata* Ach., *P. homotoma* Nyl., *P. macrocarpoides* Vain., *P. pilosa* Stein., *P. reticulata* Tayl., and *P. subisidiosa* (Müll. Arg.) Dodge.

3. Section *Imbricaria* (Schreb.) Fr. (1825, p. 242)

Lichen sect. *Imbricaria* Schreb. (1791, p. 767).

Lectotype species: *Parmelia tiliacea* (Hoffm.) Ach.

Thallus adnate; lobes sublinear to subirregular, the margins ciliate or bulbate-ciliate; lower surface black or brown, the rhizines simple or branched. Apothecia adnate, the exciple frequently coronate.

Section *Imbricaria* was first proposed by Schreber under the genus *Lichen* and characterized as follows: "Syn. *Squamaria* Hoffm. Frondes subfoliaceae, membranaceae, imbricatae, depressae, flexiles. Fr. scutellae." *Squamaria* is a genus set up by Hoffmann to accommodate the species now recognized as *Cetraria pinastri* (Scop.) Röhl. and *C. juniperina* (L.) Ach. Although Schreber cites only the Hoffmann name, we are not obliged to use it in typifying *Imbricaria*. It seems more appropriate to retain *Imbricaria* in the sense that it was so commonly used in the 19th century, that is, for the narrow lobed species of *Parmelia*. Acharius (1794) was the first to adopt Schreber's name and included under it species now classified in the genera *Physcia, Parmeliopsis, Xanthoria,* and *Parmelia*. Of these, *Parmelia tiliacea* is the most suitable choice as a lectotype for section *Imbricaria*.

Section *Imbricaria* may be divided into two subsections, *Imbricaria* and *Bicornutae* (p. 135), on the basis of whether marginal cilia or marginal bulbate cilia are present.

Subsection *Imbricaria*

Subsection *Myelochroa* Asah. (1952, p. 74).

Lectotype species: *Parmelia aurulenta* Tuck.

Thallus with simple marginal cilia, bulbate cilia lacking; lower surface usually black, the rhizines simple or sparsely branched or rarely squarrosely branched. Apothecia adnate, ecoronate.

In his study of the Japanese Parmelias, Asahina (1952) divided section *Hypotrachyna* Vain. into two subsections, *Myelochroa* (pigments present in the medulla) and *Myeloleuca* (medulla white). We have already reduced subsection *Myeloleuca* to synonymy under subsection *Parmelia*. The six pigmented species that Asahina included in subsection *Myelochroa* are all related to *P. aurulenta* Tuck. They all also have marginal cilia, a character that we consider to be of basic importance in classification. As far as we have been able to determine, medullary pigments have no value above the species level. Actually there are a number of pigmented species outside of Japan, unknown to Asahina at the time (e.g., *P. isidiocera* Nyl. and *P. silvatica* Lynge), which have branched rhizines and lack cilia and are classified below in section *Hypotrachyna*.

Subsection *Imbricaria* is a rather heterogeneous group of 33 species widely distributed in temperate and subtropical regions. The well-known species *P. dissecta* Nyl., *P. quercina* (Willd.) Vain., and *P. tiliacea* (Hoffm.) Ach. belong here. The distribution of chemical substances is very similar to subsection *Bicornutae* (cf. table 1) and the almost complete absence of sorediate species is similar. There seems to be no further natural subdivision of the subsection.

Key to Species in Subsection Imbricaria

1. Thallus isidiate or isidiate-lobulate.
   2. Isidia lobulate at maturity, dorsiventral.
      3. Medulla C+ rose (gyrophoric acid) . . . **2. P. spathulata** Kurokawa
      3. Medulla C−, KC+ rose (unknown) . . . . . **P. horrescens** Tayl.
2. Thallus isidiate, the isidia cylindrical.
   4. Medulla pigmented yellow orange, K−.
      5. Upper surface distinctly maculate . . . . . **P. perisidians** Nyl.
      5. Upper surface not maculate.
         6. Thallus saxicolous; lobes sublinear, 1.0–1.5 mm. wide.
            P. obsessa Ach.
         6. Thallus corticolous; lobes subrotund, 2–5 mm. wide.
            P. lindmannii Lynge
   4. Medulla white.
      7. Medulla K+ yellow or red, C−.
         8. Medulla K+ persistent yellow; stictic acid present.
            P. internexa Nyl.
         8. Medulla K+ yellow turning red.
            9. Norstictic acid present; tropical America . . . **P. antillensis** Nyl.
            9. Salacinic acid present; Old World.
               10. Lobes subrotund, the marginal cilia short.
                   P. wallichiana Tayl.
               10. Lobes sublinear, the marginal cilia often 1–3 mm. long.
                   P. usambarensis Stein. & Zahlbr.
      7. Medulla K−, C+ rose or red or C−.
         11. Medulla C− . . . . . **P. ikomae** Asah.
         11. Medulla C+ rose or red.

12. Cortex strongly maculate; medulla C+ red (lecanoric acid).
P. tiliacea (Hoffm.) Ach.
12. Cortex weakly maculate or emaculate; medulla C+ rose (gyrophoric acid).
13. Lobes subrotund, 2–5 mm. wide.
1. P. melanochaeta Kurokawa
13. Lobes sublinear, 1–2 mm. wide . . . . . **P. dissecta** Nyl.
1. Thallus lacking isidia or lobules.
14. Thallus pustulate; soredia scarcely if at all developed.
15. Medulla white . . . . . **3. P. subfatiscens** Kurokawa
15. Medulla pale yellow or orange yellow.
16. Lobes 1–2 mm. wide; pustules fine, not sorediate; medulla C+ rose (gyrophoric acid) . . . . . **P. spumosa** Asah.
16. Lobes 2–4 mm. wide; pustules coarsely sorediate; medulla C—.
P. aurulenta Tuck.
14. Thallus lacking pustules.
17. Thallus sorediate.
18. Medulla yellow orange . . . . . **P. aurulenta** Tuck.
18. Medulla white.
19. Thallus yellowish green (usnic acid) . . . . . **P. nylanderi** Lynge
19. Thallus mineral gray (usnic acid lacking).
20. Soredia subterminal; moniliform cells in the medulla.
P. metarevoluta Asah.
20. Soredia laminal; moniliform cells lacking . . . **P. muelleri** Vain.
17. Thallus lacking soredia.
21. Thallus pale brown below . . . . . **P. versiformis** Krempih.
21. Thallus jet black below.
22. Medulla white (even under the apothecia).
23. Medulla C+ blood red (lecanoric acid).
24. Lobes about 1 mm. wide . . . . . **P. pruinata** Müll. Arg.
24. Lobes 2–5 mm. wide.
25. Thallus strongly maculate; apothecia with retrorse rhizines . . . . . **P. carporrhizans** Tayl.
25. Thallus weakly maculate; retrorse rhizines lacking.
P. quercina (Willd.) Vain.
23. Medulla C—, P+ orange red.
26. Medulla K—, P+ (protocetraric acid).
P. michauxiana Zahlbr.
26. Medulla K+ red.
27. Thallus fragile, the cortex flaking off; spores 7–8 μ long; norstictic acid present . . . . . **P. phlyctina** Hale
27. Thallus coriaceous, the cortex firm; spores 20–28 μ long; salacinic acid present . . . . . **P. mutata** Vain.
22. Medulla yellow or yellow orange (especially under the apothecia).
28. Pigment K+ purple . . . . . **P. denegans** Nyl.
28. Pigment K— or K+ more deeply yellow.
29. Lobes sublinear, 0.5–1.5 mm. wide.
30. Medulla P+ reddish (unknown); thallus firm.
P. galbina Ach.
30. Medulla P—; thallus fragile.
P. xantholepis Mont. & v.d. Bosch.
29. Lobes subrotund, 3–6 mm. wide.

31. Upper cortex without maculae; apothecia numerous; Mexico . . . . . **P. immiscens** Nyl.
31. Upper cortex more or less distinctly maculate; Asia.
  32. Cortex fragile, flaking off . . . **P. entotheiochroa** Hue
  32. Cortex continuous, firm.
    33. Spores 7–12 μ long . . . . . **P. subaurulenta** Nyl.
    33. Spores 13–17 μ long . . . . . **P. homogenes** Nyl.

1. Parmelia melanochaeta Kurokawa, sp. nov. PLATE 3

Thallus laxe adnatus, olivaceo-albicans, 4–7 cm. latus, lobis irregularibus vel sublinearibus, subrotundatis, 2–6 mm. latis, margine crenatis, ciliatis, superne albomaculatus, isidiatus, subtus niger, rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata vel substipitata, 1–3 mm. diametro; hymenium 80–90 μ altum; sporae 8–10×13–15 μ.

Thallus loosely attached to bark, turning olive buff or cream buff (R) in the herbarium, 4–7 cm. in diameter; lobes irregularly branched, irregular to sublinear, 2–6 mm. wide, 110–150 μ thick, the margins crenate, ciliate, the cilia mostly simple, coarse, 1–2 mm. long (cf. pl. 1); upper surface shiny, rather distinctly white-maculate, moderately to densely isidiate, the isidia thin, cylindrical, often branched and with black spinules or short cilia; medulla white; undersurface black, dark brown in a rather wide zone near the tips, moderately rhizinate, the rhizines black to blackish brown, simple. Apothecia adnate to substipitate, 1–3 mm. in diameter, amphithecium isidiate, spinulate, disc vandyke brown (R); hymenium 80–90 μ high; spores 8–10×13–15 μ.

Reactions: Thallus K+ yellow; medulla K—, C+ rose, KC+ red, P—, atranorine and gyrophoric acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected at Santa Anna da Chapada, Mato Grosso, Brazil, Jan. 18, 1894, by G. A. Malme (no. 2243; isotype in US).

This is an unusual species that could be mistaken for *P. dissecta* Nyl. In fact, Lynge identified the same material as *P. minarum* Vain., a synonym of *P. dissecta* (cf. Hale, 1960). Although the chemistry of the two species is identical, *P. melanochaeta* is much larger and loosely attached and has broad rotund lobes. It seems to be common in southern Brazil and adjacent Paraguay.

Additional specimens examined: Brazil: Buriti, Cerra da Chapada, *Malme* 2243, 2397B (S); Corumbá, Mato Grosso, *Malme*, August 1894 (S). Paraguay: Gran Chaco, *Malme*, Sept. 14, 1893 (S); Colonia Risso, *Malme* 1862 Aa*, 1862 Ba*, 1911 Ba (S).

2. Parmelia spathulata Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans, 2–5 cm. diametro, lobis sublinearibus, plus minusve imbricatis, 1–3 mm. latis, margine dissectis, superne sparse ciliatis, nitidus, emaculatus, isidiato-lobulatus,

lobulis dorsiventralibus, apice dilatatis, subtus niger, rhizinosus, rhizinis nigris, sparse ramosis. Apothecia ignota.

Thallus adnate, growing over mosses on bark, pale glaucous green (R), 2–5 cm. in diameter; lobes irregularly branched, subimbricate, 1–3 mm. wide, 90–130 μ thick, the margins sparsely ciliate, dissected; upper surface shiny, without maculae, covered with numerous small isidioid lobules, the lobules dorsiventral, subascending, often branched and dilatated towards the apices; medulla white; undersurface black, rhizinate, the rhizines black, shiny, simple to sparsely branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Type in the Botanical Museum, Lund University, collected northwest of Tea-room, Skeleton Gorge, Wynberg, Cape Province, Union of South Africa, July 18, 1953, by Ove Almborn (no. 305; isotype in US).

This species is characterized by having numerous spathulate lobules and simple to sparsely branched rhizines. It is closely related to *P. dissecta* Nyl., which has similar chemistry but cylindrical isidia rather than lobules. *Parmelia spathulata* is apparently restricted to South Africa.

Additional specimens examined: Union of South Africa: Polela Forest, Polela, Natal, *Almborn* 9516 (LD, US); Kirstenbosch, Cape Province, *Arnell* 437 (LD).

3. Parmelia subfatiscens Kurokawa, sp. nov.

Thallus adnatus, albido-cinerascens, 4–7 cm. latus, lobis sublinearibus, 0.5–1.5 mm. latis, margine ciliatis, superne planus, emaculatus, pustulatus, subtus niger, dense rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1.5–4.0 mm. diametro; hymenium 60–75 μ altum; sporae 8–9×12–14 μ.

Thallus adnate on bark, pale olive gray to light mineral gray (R), 4–7 cm. in diameter; lobes dichotomously or irregularly branched, sublinear-elongate, 0.5–1.5 mm. wide, 80–100 μ thick, the margins crenate, ciliate, the cilia black, simple, 0.5–1.0 mm. long; upper surface plane and smooth, shiny, not maculate, pustulate, the pustules not becoming sorediate, often ciliate; medulla white; undersurface black, densely rhizinate, the rhizines black, simple, about 1.0 mm. long. Apothecia adnate, 1.5–4.0 mm. in diameter, margins smooth, disc clove brown (R), radially split; hymenium 60–75 μ high; spores 8–9×12–14 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ rose, P−, atranorine and an unknown KC+ substance present.

Type in the Botanical Museum, Lund University, collected at Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal,

Union of South Africa, Oct. 10, 1953, by Ove Almborn (no. 6443; isotype in US).

This species is very close to *P. dissecta* Nyl. but it is distinctly pustulate rather than isidiate and the medulla is C—, whereas *P. dissecta* is C+ rose (gyrophoric acid). The pustules are similar to those of *P. spumosa* Asah., a smaller species with a pale yellow medulla and gyrophoric acid. *Parmelia subfatiscens* has the same West Indies-Africa distribution characteristic of *P. exsplendens* Hale, *P. suffixa* Stirt., and *P. ventricosa* Hale & Kurokawa.

Additional specimens examined: Jamaica: Blue Mountains: North slope below Corn Puss, *Imshaug* 14550 (MSC); New Haven Gap, *Imshaug* 15137 (MSC, US). Union of South Africa: Natal: Boschfontein Forest, Lions River Distr., *Almborn* 8717 (LD); Transvaal: Forest Drive from Houtbosch to Tzaneen, Pietersburg, *Almborn* 6797 (LD); Cape Province: Deepwalls, Knysna, *Almborn* 3433 (LD).

Subsection *Bicornutae* (Lynge) Hale & Kurokawa, comb. nov.

Section *Bicornuta* Lynge (1913, p. 17). Type species: *P. semilunata* Lynge.
Subgenus *Bicornuta* (Lynge) Gyel. (1932, p. 219).

Thallus with marginal bulbate cilia; lower surface black or brown, the rhizines simple or branched. Apothecia frequently coronate.

Lynge first proposed section *Bicornuta* on the basis of two species, *P. semilunata* and *P. schiffneri* Zahlbr., both of which have peculiar bicornute spores. As a matter of fact, there is apparently only one other species in *Parmelia* with such spores, *P. bicornuta* Müll. Arg. However, these species also have marginal bulbate cilia, one of the most fundamental characters that we have found in subgenus *Parmelia*. Normally ciliate species (subsection *Imbricaria*) appear to be closely related in chemistry (see table 1).

This subsection of 46 primarily tropical species may be further subdivided into two series, based on the presence or absence of usnic acid, as follows:

Series *Bicornutae*

Thallus mineral gray; usnic acid lacking.

Series *Relicinae* Hale & Kurokawa, ser. nov.

Thallus stramineus vel viridiflavicans, acidum usnicum continens.

Type species: *Parmelia relicina Fr.*

When the bulbate-ciliate species are divided on the presence or absence of usnic acid, there is significant geographical correlation. In the series *Bicornutae* seven of the nine species with salacinic acid occur only in Africa. Of the nine C+ species, six are restricted to tropical America. Among the remaining species, five occur only in South America, two in Africa, one in America-Africa, and one

in Asia. In other words, the species in this series are most common in Africa and South America.

In the series *Relicinae* there are no species at all in Africa. Thirteen occur only in southeastern Asia and Australia, two in tropical America and the Pacific, two in tropical America only, and one in America-Asia. This series then shows very strong representation in southeastern Asia.

Key to Species in Subsection Bicornutae Series Bicornutae

1. Thallus isidiate or lobulate-isidiate.
   2. Lower surface pale brown.
      3. Medulla K+ red (salacinic acid).
         4. Thallus large, the lobes 2–5 mm. wide; upper surface not distinctly maculate . . . . . **P. isidiza** Nyl.
         4. Thallus smaller, the lobes 1.0–2.5 mm. wide; upper surface distinctly maculate . . . . . **P. subglandulifera** Hue
      3. Medulla K−, C+ rose (gyrophoric acid). . . . . **P. scortella** Nyl.
   2. Lower surface jet black.
      5. Isidia becoming dorsiventral, lobulate; medulla C+ rose (gyrophoric acid).
         6. Apothecia ecoronate. . . . . **P. suffixa** Stirt.
         6. Apothecia coronate. . . . . **P. fungicola** Lynge
      5. Isidia normal, cylindrical.
         7. Medulla K+ red.
            8. Norstictic acid present . . . . . **6. P. ventricosa** Hale & Kurokawa
            8. Salacinic acid present.
               9. Plants saxicolous . . . . . **4. P. decurtata** Kurokawa
               9. Plants corticolous . . . . . **P. tabacina** Mont. & v. d. Bosch.
         7. Medulla K−.
            10. Medulla C−, KC+ red (unknown present).
                2. P. apophysata Hale & Kurokawa
            10. Medulla C+ rose or red.
               11. Medulla C+ deep red (lecanoric acid) . . . **P. laevigatula** Nyl.
               11. Medulla C+ rose (gyrophoric acid).
                  12. Thallus tightly adnate, the lobes 0.5–1.0 mm. wide; Asia.
                      P. subdissecta Nyl.
                  12. Thallus loosely adnate, the lobes 1.0–3.0 mm. wide; tropical America . . . . . **P. papyrina** Fée
1. Thallus without isidia.
   13. Lower surface pale brown.
      14. Apothecia coronate; norstictic acid present . **P. subcoronata** Müll. Arg.
      14. Apothecia ecoronate; salacinic acid present.
         15. Upper surface distinctly maculate . . . . . **P. hypocraea** Vain.
         15. Upper surface dull, not maculate.
            16. Thallus small, the lobes 0.7–2.0 mm. wide; South America.
                P. continua Lynge
            16. Thallus medium sized, the lobes 2.0–5.0 mm. wide; Asia.
                P. setschwanensis Zahlbr.
   13. Lower surface jet black.
      17. Medulla K+ red (salacinic acid).

18. Upper surface coarsely pustulate, pustules breaking open, esorediate.
5. P. pustulata Hale

18. Upper surface smooth, pustules lacking.
19. Spores 7–9 μ long; Africa . . . **P. sensibilis** Stein. & Zahlbr.
19. Spores 14–19 μ long; eastern Asia . . . **P. meizospora** (Nyl.) Nyl.

17. Medulla K−.
20. Medulla C−.
21. Thallus adnate, the lobes 1–2 mm. wide.
22. Thallus coriaceous; bulbate cilia conspicuous; India.
3. P. bulbochaeta Hale
22. Thallus fragile; bulbate cilia small; South America.
P. viridescens Lynge
21. Thallus appressed, the lobes less than 1 mm. wide.
23. Lobes 0.3–1.0 mm. wide; spores elliptical.
1. P. affixa Hale & Kurokawa
23. Lobes 0.1–0.2 mm. wide; spores bicornute.
24. Spores 4–5 μ long . . . . . **P. schiffneri** Zahlbr.
24. Spores 15–20 μ long. . . . . **P. semilunata** Lynge

20. Medulla C+ rose or red.
25. Medulla C+ deep red (lecanoric acid).
26. Spores bicornute . . . . . **P. bicornuta** Müll. Arg.
26. Spores elliptical . . . . . **P. confoederata** Culb.
25. Medulla C+ rose (gyrophoric acid).
27. Apothecia coronate; upper cortex without maculae **P. coronata** Fée
27. Apothecia ecoronate; upper cortex distinctly maculate.
P. atrichella Nyl.

1. Parmelia affixa Hale & Kurokawa, stat. et nom. nov.

Parmelia coronata Fée var. *denudata* Vain. *in* Welw. Cat. Afr. Pl. 2, no. 2:401. 1901. Type collection: Morro de Lopollo, Huilla, Angola, *Welwitsch* 33 (TUR, holotype; BM, isotype).

Thallus very closely adnate on bark, turning olive buff to tea green in the herbarium, about 3 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 0.3–1.0 mm. wide, 70–90 μ thick, the margins more or less crenate, with dense bulbate cilia; upper surface plane, shiny, emaculate, cracked on older lobes, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, rhizines black, shiny, simple. Apothecia numerous, adnate, 0.5–1.5 mm. in diameter, exciple smooth to crenate, coronate, the base retrorsely rhizinate; hymenium 40–50 μ high; spores 4–5×8–10 μ, episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ rose, P−, atranorine and a KC+ rose unknown substance (not further identified because of paucity of material).

The name *Parmelia denudata* has already been used by Hampe (Linnaea 17:121. 1843) for a species now recognized as *Everniopsis trulla* (Ach.) Nyl. *Parmelia affixa* is a small easily overlooked species that is probably more common than suspected in southwest Africa. It is one of the few coronate species in Africa.

Additional specimen examined: Africa: 10 km, north of Sá da Bandeira, Huila, Angola, *Degelius*, Mar. 2, 1960 (DEGEL, US).

2. Parmelia apophysata Hale & Kurokawa, sp. nov.

Thallus arcte adnatus, corticola, albido-olivascens, 3–6 cm. diametro, lobis sublinearibus, 0.7–1.5 mm. latis 90–130 μ crassis, margine bulbato-ciliatis, superne nitidus, isidiatus, isidiis cylindricis, subtus niger, rhizinosus, rhizinis dichotome ramosis. Apothecia ignota.

Thallus closely adnate on bark, turning light olive buff in the herbarium, 3–6 cm. in diameter; lobes sublinear-elongate, more or less dichotomously branched, 0.7–1.5 mm. wide, 90–130 μ thick, the margins densely bulbate-ciliate; upper surface plane, shiny, sometimes faintly maculate, often irregularly cracked on older lobes, sparsely to moderately isidiate, isidia simple, cylindrical, less than 0.3 mm. high; undersurface black, with a broad pale brown zone near the tips of lobes, short rhizinate, rhizines pale to black, shiny, densely branched. Apothecia unknown.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P−, atranorine and an unknown KC+ substance (near alectoronic acid?) present.

Type in the U.S. National Herbarium, collected on mangrove tree in pine barrens, vicinity of Piedra Blanca, La Vega, Dominican Republic, Oct. 14, 1947, by H. A. Allard (no. 16073).

Parmelia apophysata is characterized by having a medium-sized thallus, simple cylindrical isidia, bulbate cilia and branched rhizines, and faintly maculate lobes. The unknown KC+ substance is noticeably fluorescent in ultraviolet light. This species resembles *P. subdissecta* Nyl., which has more adnate smaller lobes and a C+ pale-red reaction caused by gyrophoric acid. *Parmelia apophysata* is known only from the type collection but it is certain to be found in other collections from tropical America.

3. Parmelia bulbochaeta Hale, sp. nov. PLATE 1

Thallus adnatus vel laxe adnatus, albido-cinerascens, coriaceus, 4–8 cm. diametro, lobis sublinearibus, 1.5–2.5 mm. latis, margine bulbato-ciliatis, superne planus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus nigricans, dense rhizinosus, rhizinis nigricantibus, dichotome ramosis. Apothecia adnata, coronata, 2–3 mm. diametro; hymenium 40–50 μ altum; sporae 4×5 μ.

Thallus adnate to loosely adnate, dark mineral gray, coriaceous, 4–8 cm. in diameter; lobes sublinear, 1.5–2.5 mm. wide, 160–210 μ thick, the margins entire, conspicuously bulbate-ciliate, bulbules with simple or branched apical cilia; upper surface plane, shiny, without maculae, usually heavily pycnidiate, soredia and isidia lacking; medulla white, dense; undersurface black, becoming brown at the

tips, densely rhizinate, rhizines black, brownish black near the margins, dichotomously branched. Apothecia adnate, 2–3 mm. in diameter, coronate; hymenium 40–50 μ high; spores 4×5 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, only atranorine present.

Type in the herbarium of D. D. Awasthi, collected at Perumal coffee plantation, Shembaganur, Madurai district, India, elev. 5300–5700 ft., Dec. 23, 1959, by D. D. Awasthi (no. 4347; isotype in US).

Parmelia bulbochaeta resembles the South American species *P. coronata* Fée and *P. viridescens* Lynge in the presence of coronate apothecia, black undersurface, and branched rhizines, and in the absence of maculae. It differs in having a more robust coriaceous thallus and more conspicuous bulbate cilia and no chemicals other than atranorine. It is known only from two collections made in South India.

Additional specimen examined: College compound, Shembaganur, Madurai, India, *Awasthi* 4275 (AWAS).

4. Parmelia decurtata Kurokawa, sp. nov.

Thallus adnatus, saxicola, olivaceo-cinerascens, 3–7 cm. latus, lobis subirregularibus, subimbricatis, 1–3 mm. latis, margine crenatis, bulbato-ciliatis, superne planus, nitidus, emaculatus, isidiatus, subtus nigricans, rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus closely adnate on rock, pale olive buff to pale olive gray (R), 3–7 cm. in diameter; lobes irregularly branched, subirregular to sublinear, more or less imbricate, 1–3 mm. wide, 220–300 μ thick, the margins crenate, moderately bulbate-ciliate; uppersurface plane, shiny, often cracked on older lobes, isidiate, the isidia cylindrical, often more or less granular, rarely branched; medulla white; undersurface dark brown to black, moderately to densely rhizinate, the rhizines black, simple, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Type in the Botanical Museum, Lund University, collected 10 miles southeast of Lydenburg, Transvaal, Union of South Africa, Oct. 20, 1953, by Ove Almborn (no. 7388; isotype in US).

Parmelia decurtata bears a very close resemblance to *P. tabacina* Mont. & v.d. Bosch., a widespread corticolous species. They both have isidia, bulbate cilia, and salacinic acid. *Parmelia decurtata* differs in being strictly saxicolous, lacking any trace of maculae, and having smaller, often papillate, black-tipped isidia.

Additional specimens examined: Union of South Africa: Natal: Cathedral Peak Area, Bergville Distr., elev. 6000 ft., *Almborn* 9328

(LD); Cape Province: Bains Kloof, Wellington Distr., *Almborn* 5053 (LD).

5. Parmelia pustulata Hale, sp. nov.

Thallus adnatus, corticola, membranaceus, 6–10 cm. diametro, olivaceo-albicans, lobis subirregularibus, 4–6 mm. latis, apice subrotundatis, margine bulbato-ciliatis, superne planus vel rugosus, nitidus, isidiato-pustulatus, pustulis inflatis, subtus niger, modice rhizinosus, rhizinis simplicibus, ambitu castaneus, nudus vel papillatus. Apothecia ignota.

Thallus adnate on bark, membranaceous, 6–10 cm. in diameter, olivaceous to light mineral gray; lobes more or less subirregular, 4–6 mm. wide, the apices subrotund, the margins broadly crenate, inconspicuously bulbate-ciliate; upper surface plane to rugose, shiny, becoming moderately isidiate-pustulate, pustules inflated, irregular, breaking open apically, soredia absent; medulla white; lower surface black and moderately rhizinate at the center, the rhizines black, simple, the marginal zone bare or papillate, brown. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Type in the U.S. National Herbarium, collected in a bamboo forest, Urundi, Africa, elev. 2200 m., by Deuse (communicated by Dr. J. L. Ramaut, Liège, Belgium).

This species is unique in subsection *Bicornutae* in having large distinct pustules. Isidiate *P. tabacina* Mont. & v.d. Bosch. has similar lobe configuration and chemistry and is probably related to it. *Parmelia pustulata* is known only from the type collection.

6. Parmelia ventricosa Hale & Kurokawa, stat. et nom. nov.

Parmelia isidiza var. *domingensis* Vain. Ann. Acad. Sci. Fenn. 6, no. 7:17. 1915. Type collection: La Cumbra, Santo Domingo (Dominican Republic), *Raunkiaer* 492 (TUR, holotype; C, isotype).

Thallus adnate on bark, pale glaucous green, 3–5 cm. in diameter; lobes irregularly branched, 1–5 mm. wide, 65–80 μ thick; margins crenate, with bulbate cilia; upper surface plane and smooth, shiny, weakly maculate, more or less wrinkled on older lobes, isidiate, the isidia mostly simple, fine and short; medulla white; undersurface uniformly black, short-rhizinate, the rhizines black, simple. Apothecia adnate, coronate, more than 2.5 mm. in diameter, exciple crenate, amphithecium smooth, weakly maculate, disc russet, imperforate; hymenium 50–60 μ high; spores 7–8$\times$13–17 μ, the episporium 1.0–1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange, atranorine and norstictic acid present.

The name *Parmelia domingensis* is preoccupied by *P. domingensis* Ach., which is now recognized as a species of *Anaptychia*. *Parmelia ventricosa* and *P. isidiza* Nyl. share isidia and bulbate cilia, but *P. ventricosa* has coronate apothecia and norstictic acid. *Parmelia isidiza*, a common African lichen, has ecoronate apothecia and salacinic acid. *Parmelia ventricosa* is a rather rare species in the Caribbean region with a disjunct locality in South Africa.

Additional specimens examined: Mexico: Chiapas: Near ranch, El Suspiro, *Hale* 20166 (US). Union of South Africa: Transvaal: Drive from Houtbosch to Tzaneen, Pietersburg, *Almborn* 6813 (LD).

Key to Species in Subsection Bicornutae Series Relicinae

1. Thallus isidiate or isidiate-lobulate.
   2. Isidia dorsiventral, lobulate.
      3. Medulla P+ red (unknown) . . . . . **7. P. schizospatha** Kurokawa
      3. Medulla P−, C+ rose (gyrophoric acid) . **4. P. luteoviridis** Kurokawa
   2. Isidia normal, cylindrical.
      4. Lower surface pale to dark brown.
         5. Upper surface maculate; rhizines simple.
            9. P. tumescens Hale & Kurokawa
         5. Upper surface emaculate; rhizines branched . **P. circumnodata** Nyl.
      4. Lower surface jet black.
         6. Lobes more or less subirregular, to 3 mm. wide; medulla P+, K− (unknown) . . . . . **5. P. planiuscula** Kurokawa
         6. Lobes sublinear, 1–2 mm. wide; medulla P+, K+ red (norstictic acid). **P. abstrusa** Vain.
1. Isidia and lobules lacking.
   7. Lower surface pale to dark brown.
      8. Base of apothecia retrorsely rhizinate; plants saxicolous; stictic acid present . . . . . **P. limbata** Laur.
      8. Base of apothecia without retrorse rhizines; plants corticolous; stictic acid lacking.
         9. Rhizines black; protocetraric acid present.
            6. P. ramosissima Kurokawa
         9. Rhizines uniformly pale brown.
            10. Medulla K+ red (salacinic acid) . . . **1. P. acrobotrys** Kurokawa
            10. Medulla K− (protocetraric acid) . . . **8. P. sublanea** Kurokawa
   7. Lower surface jet black.
      11. Medulla P−, K−.
         12. Lobes appressed, 0.2–0.8 mm. wide . . . **P. relicinula** Müll. Arg.
         12. Lobes adnate, 0.7–2.0 mm. wide.
            13. Rhizines mostly branched; protolichesteric acid present.
               2. P. connivens Kurokawa
            13. Rhizines mostly simple; fatty acids absent . . . . **P. relicina** Fr.
      11. Medulla P+, K+ red or K−.
         14. Medulla K+ red (norstictic acid) . . . . **P. subabstrusa** Gyel.
         14. Medulla K−.
            15. Apothecia ecoronate; P+ unknown present . **P. sublimbata** Nyl.
            15. Apothecia coronate; fumarprotocetraric acid present.

16. Asci 16–32-spored . . . . . **P. relicinella** Nyl.
16. Asci 8-spored.
17. Marginal bulbules ciliate, 0.3–1.0 mm. long; Pacific area. **P. samoensis** Zahlbr.
17. Marginal bulbules not ciliate, 0.1–0.2 mm. long; tropical America . . . **3. P. eximbricata** (Gyel.) Hale & Kurokawa

1. Parmelia acrobotrys Kurokawa, sp. nov. PLATE 2

Thallus adnatus, viridi-flavicans, 6–12 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine bulbato-ciliatis, superne plerumque convexus, albomaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, modice rhizinosus, rhizinis dense ramosis, pallidis. Apothecia substipitata, 1.0–3.5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5×7–8 μ.

Thallus adnate on bark, olive buff (R), 6–12 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.0–2.5 mm. wide, 240–320 μ thick, the margins smooth, with bulbate cilia; upper surface more or less convex, shiny, maculate, isidia and soredia lacking; medulla white; undersurface pinkish buff (R), moderately rhizinate, rhizines densely branched towards the tips, pale. Apothecia substipitate, without retrorse rhizines, 1.0–3.5 mm. in diameter, exciple crenate, amphithecium smooth, disc burnt amber (R); hymenium 50–60 μ high; spores 4–5×7–8 μ.

Reactions: Thallus K+ yellowish; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine, usnic acid, and salacinic acid.

Type in Herbarium Bogoriense, collected at Tjibodas, Java, May 1949, by Neervoort (no. 60 pr. p.; isotype in US).

Parmelia acrobotrys is closely related to *P. sublanea* Kurokawa. Both species have a pale undersurface, pale brown rhizines, ecoronate apothecia, and similar spores. *Parmelia acrobotrys* has coarser rhizines and contains salacinic acid, whereas *P. sublanea* contains protocetraric acid. The saxicolous species *P. limbata* Laur. is superficially similar but contains stictic acid. *Parmelia acrobotrys* is known only from the type collection.

2. Parmelia connivens Kurokawa, sp. nov. PLATE 2

Thallus adnatus, viridiflavicans, 3–5 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine bulbato-ciliatis, superne planus vel convexus, sorediis et isidiis destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1.0–2.5 mm. diametro, retrorso-rhizinata; hymenium 45–60 μ altum; sporae 2–3×4–6 μ.

Thallus adnate, deep sea-foam green (R), turning cinnamon buff (R) in the herbarium, 3–5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.0–2.5 mm. wide, 120–160 μ thick, the

older lobes becoming lobulate, the margins smooth, narrowly black-rimmed near the tips, with bulbate cilia; upper surface plane to slightly convex, smooth but becoming rugulose and cracked on older lobes, soredia and isidia lacking; undersurface almost uniformly black, densely rhizinate, the rhizines black, irregularly branched, sometimes projecting beyond the margins. Apothecia adnate, 1.0–2.5 mm. in diameter, retrorsely rhizinate, exciple crenate, disc seal brown (R); hymenium 45–60 μ high; spores 2–3×4–6 μ.

Reactions: Thallus K+ yellowish; medulla K−, C−, KC−, P−, atranorine, usnic acid, and protolichesteric acid present.

Type in the Kew Herbarium, collected in the Milne Bay district, Papua, New Guinea, Sept. 11, 1954, by R. D. Hoogland (no. 4726; isotypes in L, US).

At first glance this species resembles *P. acrobotrys* Kurokawa and *P. ramosissima* Kurokawa but it is easily distinguished by the black undersurface and the negative reaction with P. No other species in series *Relicinae* produces a fatty acid. It is a typical Indonesian species.

Additional specimens examined: Molucca Islands: Tanimbar Island, P. Jamdena, *Buwalda* 4246 (BO). Guam: *McGregor* s.n. (H).

3. Parmelia eximbricata (Gyel.) Hale & Kurokawa, comb. nov.

Parmelia samoensis Zahlbr. var. *eximbricata* Gyel. Ann. Mycol. 36:288. 1938. Type collection: Monte Rus, Cuba, *Hioram* 10506 (BP, holotype).

Thallus closely adnate on bark, massicot yellow (R), 3–5 cm. in diameter; lobes more or less dichotomously branched, sublinear, 0.7–1.5 mm. wide, 160–200 μ thick; margins crenate, with small bulbate cilia, 0.1–0.2 mm. long; upper surface plane, smooth and shiny emaculate, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, the rhizines black, simple. Apothecia common, adnate, 0.5–1.5 mm. in diameter, exciple coronate, the base of the amphithecium often retrorsely rhizinate; hymenium 45–55 μ high; spores 4–5×7–9 μ, the episporium 1 μ thick.

Reactions: Thallus K−; medulla K−, C−, KC−, P+ brick red, fumarprotocetraric acid and usnic acid present.

Parmelia eximbricata resembles the Pacific species *P. samoensis* Zahlbr. in having coronate apothecia and fumarprotocetraric acid. The marginal bulbate cilia of *P. samoensis* however are longer and more conspicuous, and tipped with distinct cilia. This species is widely distributed in the Caribbean as far north as southern Florida, usually occurring at low elevations.

Additional specimens examined: Florida: Big Pine Key, Florida Keys, *Swanson & Dowling* C–795 (US). Jamaica: Wareika House, summit of Long Mountain, St. Andrew *Imshaug* 13492 (MSC); north

slope of Montpelier, St. Catherine, *Imshaug* 14261 (MSC, US). Grand Cayman: Near Georgetown, *Imshaug* 24385 (MSC); center of Island, *Imshaug* 24518 (MSC, US). Dominican Republic: Vicinity of Ciudad Trujillo, Santo Domingo, *Allard* 16186, 16192 (US); near Río Chavón, east of La Romana, La Altagracia, *Hassler*, July 31, 1935 (WISC). Cuba: Without locality, *Wright*, *Lich. Cub.* ser. II, 10 (US).

4. Parmelia luteoviridis Kurokawa, sp. nov. PLATE 2

Thallus adnatus, corticola, viridiflavicans, ca. 7 cm. diametro, lobis sublinearibus, 1.5–3.0 mm. latis, margine dense lobulatis, bulbato-ciliatis, superne nitidus, lobulatus, lobulis vulgo ramosis, subtus niger, rhizinosus, rhizinis nigris, sparse ramosis. Apothecia ignota.

Thallus adnate on bark, deep sea-foam green to light dull green yellow (R), about 7 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1.5–3.0 mm. wide, 160–200 μ thick, the margins lobulate, with shiny bulbate cilia; upper surface plane and smooth, shiny, faintly maculate, lobulate, the lobules dorsiventral, not ascending, often dichotomously branched, rhizinate below; undersurface black, rhizinate, the rhizines black, shiny, sparsely branched. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K—, C+ rose, KC+ red, P—, atranorine, usnic acid, and gyrophoric acid.

Type in the Herbarium Bogoriense, collected on peak of B. Papan, Beu territory, E. Kutai, Borneo, July 8, 1952, by W. Meijer (no. B1948; isotype in US).

This species is characterized by the conspicuous yellow richly lobulate thallus and by the production of gyrophoric acid. It is the only species in series *Relicinae* with a C+ substance. It resembles *P. schizospatha* Kurokawa in having lobules and a black lower surface but has wider lobes and greater development of lobules. *Parmelia schizospatha* is C—, P+ red. *Parmelia luteoviridis* is still known only from the type locality.

Additional specimen examined: Borneo: Same data as the holotype, *Meijer* B1548a (B0).

5. Parmelia planiuscula Kurokawa, sp. nov.

Thallus adnatus, corticola, viridiflavicans, usque ad 9 cm. latus, lobis sublinearibus, 1–3 mm. latis, margine subcrenatis, bulbato-ciliatis, superne planus, nitidus, sparse isidiatus, subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus adnate to loosely attached over mosses on bark, rather rigid, turning deep olive buff (R) in the herbarium, about 9 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–3 mm.

wide, 150–190 μ thick, the margins more or less crenate, with bulbate cilia; upper surface plane and smooth, shiny, faintly maculate, sparsely isidiate, isidia simple, cylindrical, less than 0.7 mm. high; medulla white; undersurface black, moderately rhizinate, the rhizines black, shiny, simple. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K−, C−, KC−, P+ orange red, atranorine, usnic acid, and an unknown P+ substance.

Type in the Herbarium Bogoriense, collected at Kandang Badak, Java, May 27, 1949, by Neervoort (no. 427; isotype in US).

Externally this species resembles *P. tumescens* Hale & Kurokawa. It differs in having a black undersurface and a P+ unknown substance instead of stictic acid. *Parmelia circumnodata* Nyl., a much smaller lichen, has short sparse isidia, a pale undersurface with branched rhizines, and protocetraric acid. *Parmelia abstrusa* Vain., the fourth isidiate species in series *Relicinae*, has a thick rigid thallus and produces norstictic acid. *Parmelia planiuscula* is still known only from the type locality.

6. Parmelia ramosissima Kurokawa, sp. nov. PLATE 2

Thallus adnatus, corticola, obscure viridiflavicans, ca. 3 cm. diametro, lobis sublinearibus, 0.7–2.0 mm. latis, margine integris, bulbatociliatis, superne nitidus, albomaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, rhizinosus, rhizinis nigricans, dense ramosis. Apothecia adnata, ecoronata, retrorso-rhizinata; hymenium 40–50 μ altum; sporae 2×3 μ.

Thallus adnate on bark, turning dark olive buff (R) in the herbarium, more than 3 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 0.7–2.0 mm. wide, 200–240 μ thick, the margins smooth, with bulbate cilia; upper surface plane and smooth, rather shiny, maculate, isidia and soredia lacking; medulla white; undersurface pale brown to brown, moderately rhizinate, the rhizines blackening, finely and densely branched. Apothecia adnate, ecoronate, 1.0–2.5 mm. in diameter, exciple crenate, often basally retrorsely rhizinate, disc warm blackish brown (R); hymenium 40–50 μ high; spores about 2×3 μ.

Reactions: Thallus K+ yellowish; medulla K−, C−, KC+ reddish, P+ orange red, usnic acid and protocetraric acid present.

Type in Herbarium Bogoriense, collected on Tanimbar Island, Moluccas, Apr. 2, 1938, by P. Buwalda (no. 4583; isotype in US).

This species resembles *P. acrobotrys* Kurokawa in habit and in the pale undersurface. However, *P. ramosissima* is distinctly maculate and contains protocetraric rather than salacinic acid. It has the smallest spores of any species in section *Relicinae*. It is presently known only from the type locality.

7. Parmelia schizospatha Kurokawa, sp. nov. PLATE 2

Thallus adnatus, corticola, obscure viridiflavicans, ca. 5 cm. diametro, lobis sublinearibus, 1–2 mm. latis, margine subcrenatis, bulbato-ciliatis, lobulatis, lobulis ramosis, superne planus, nitidulus, lobulatus, subtus niger, modice rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus adnate on bark, turning deep olive buff (R) in the herbarium, about 5 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–2 mm. wide, 100–120 μ thick, the margins more or less crenate, with black bulbate cilia, lobulate, the lobules dorsiventral, often dichotomously branched, not ascending; upper surface plane and smooth, faintly maculate, somewhat shiny, lobulate, the lobules the same as the marginal ones; undersurface black, moderately rhizinate, the rhizines black, shiny, simple. Apothecia not seen.

Reactions: Thallus K+ yellowish; medulla K−, C−, KC−, P+ orange red, usnic acid and an unknown P+ substance present.

Type in Herbarium Bogoriense, collected at Gegerbentang, Java, June 27, 1949, by Neervoort (no. 1062; isotype in US).

This new species is identical with *P. sublimbata* Nyl. in chemistry but it is distinctly lobulate. The lobules are quite fragile and frequently branched. At present the species is known only from the type locality.

8. Parmelia sublanea Kurokawa, sp. nov.

Thallus adnatus, rigidulus, obscure viridiflavicans, ca. 10 cm. diametro, lobis sublinearibus, subimbricatis, 1–2 mm. latis, margine integris, bulbato-ciliatis, ciliis apice ramosis, superne planus vel convexus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus pallide castaneus, dense rhizinosus, rhizinis pallide castaneis, dense ramosis. Apothecia substipitata, 1.0–4.5 mm. diametro; hymenium 40–50 μ altum; sporae 4–5×7–9 μ.

Thallus rather rigid, olive buff to deep olive buff (R), corticolous, about 10 cm. in diameter; lobes dichotomously branched, sublinear-elongate, subimbricate, 1–2 mm. wide, 220–300 μ thick, the margins entire, often brown rimmed, with bulbate cilia; upper surface plane to more or less convex, smooth and shiny, without maculae, isidia and soredia lacking; medulla white; undersurface pale brown, densely rhizinate, the rhizines pale brown, densely branched, often forming a woolly mat. Apothecia substipitate, 1.0–4.5 mm. in diameter, exciple crenate, more or less undulate, amphithecium smooth, disc seal brown (R); hymenium 40–50 μ high; spores 4–5×7–9 μ

Reactions: Thallus K+ yellowish; medulla K−, C−, KC+ reddish, P+ orange red, usnic acid and protocetraric acid present.

Type in Herbarium Bogoriense, collected on route between Ake

Biaur and Tolewang, Halmahera Island, Oct. 12, 1951, by P. Groenhardt (no. 8409; isotype in US).

As previously discussed, *P. sublanea* is very similar to *P. acrobotrys* except in chemistry. *Parmelia ramosissima* has similar chemistry but the rhizines are darker. The bulbate cilia of *P. sublanea* are unusual in being almost spherical and quite large. The species is known only from the type locality.

9. Parmelia tumescens Hale & Kurokawa, stat. et nom. nov.

Parmelia limbata Laur. f. *isidiosa* Müll. Arg. Flora 70:59. 1887. Type collection: Richmond River, Australia, *Hodgkinson* s.n. (G, holotype).

Thallus adnate on bark, turning deep olive buff in the herbarium about 4 cm. in diameter; lobes dichotomously branched, sublinear, 1.0–1.5 mm. wide, 190–230 μ thick, the margins subcrenate, with bulbate cilia; upper surface more or less convex, irregularly cracked on older lobes, white-maculate, isidiate, the isidia cylindrical, simple or branched, up to 0.5 mm. high; medulla white; undersurface brown, moderately rhizinate, the rhizines simple, rather thick, dark brown to black. Apothecia not seen.

Reactions: Thallus K—; medulla K+ yellow, C—, KC—, P+ pale orange red, usnic acid and stictic acid present.

The specific epithet *isidiosa* is preempted by *Parmelia isidiosa* (Müll. Arg.) Hale, a species in subgenus *Xanthoparmelia*. Except for the presence of isidia, *P. tumescens* is very similar to P. *limbata* Laur., another Australian species that occurs commonly on rocks rather than bark.

Additional specimens examined: Australia: Eastern Creek, New South Wales, *Wilson* (H); Brisbane, Queensland, *Bailey* (BM).

4. Section *Cyclocheila* (Vain.) Räs. (1943, p. 10)

Section *Hypotrachyna* **Cyclocheila* Vain. (1890, p. 47).
Pseudoparmelia Lynge (1913, p. 15). Type species: *P. cyphellata* (Lynge) Sant.
Section *Subflavescentes* (Vain.) Gyel. subsection *Eciliatae* Gyel. (1932, p. 225). Lectotype: *P. caperata* (L.) Ach.
Section *Hypotrachyna* subsection *Cyclocheila* (Vain.) Gyel. (1932, p. 224).
Section *Hypotrachyna* subsection *Cyclocheila* (Vain.) Hillm. (1934, p. 187). Superfluous combination.
Section *Pseudoparmelia* (Lynge) Räs. (1943, p. 10).

Lectotype species: *Parmelia amazonica* Nyl.

Thallus adnate to loosely attached; lobes sublinear and truncate to subirregular and subrotund; lower surface black or brown, the rhizines simple, often coarse.

As we previously mentioned (p. 129), Vainio first recognized *Cyclocheila* as a group under section *Hypotrachyna*, characterized by

subrotund lobes and including three species, *P. amazonica* Nyl., *P. minarum* Vain. (=*P. dissecta* Nyl.), and *P. muelleri* Vain. The latter two species are ciliate and should be classified in our section *Imbricaria* subsection *Imbricaria*. Vainio (1923) later combined this group and *Irregulares* into a single section *Irregulares* (Vain.) Vain. We have amended section *Irregulares* to include only species with a reticulate upper cortex, marginal cilia, and usually squarrosely branched rhizines.

The type species of section *Cyclocheila*, *Parmelia amazonica*, has simple unbranched rhizines and lacks any marginal cilia. There are 45 additional eciliate species with simple rhizines that can be classified here. These include typical sublinear-lobed species (e. g., *P. sphaerospora* Nyl., *P. texana* Tuck.) and a number of subirregular, subrotund-lobed species, such as *P. amazonica* Nyl., *P. caperata* (L.) Ach., *P. caroliniana* Nyl., and *P. soredians* Nyl. Some of these species have a narrow bare or papillate zone below at the margins and could be confused with species in subgenus *Amphigymnia*. Section *Cyclocheila* is best represented in Africa where 18 of the species are endemic; they are often saxicolous. Divaricatic acid is especially common along with a number of other K−, P− acids also found in section *Hypotrachyna* (see below, also cf. table 1).

Lynge first proposed the genus *Pseudoparmelia* on the supposed discovery of "pseudocyphellae" on the lower surface of *Parmelia cyphellata*, a mistake followed by Räsänen (1943). Santesson (1944) has conclusively shown that these structures are merely breaks or gashes in the lower cortex where rhizines have been torn away. Gyelnik (1933) used this genus name to accommodate the pseudocyphellate *Amphigymnia* species related to *Parmelia cetrarioides* (Duby) Nyl., but this application of the name seems to be incorrect.

In his original publication, Räsänen (1943) did not actually indicate himself as the author of section *Cyclocheila* but listed Vainio alone, apparently on the mistaken assumption that Vainio had recognized this taxon at the sectional level previously. Räsänen clearly cites *Cyclocheila* as a section, however, and we believe he should be cited as the author of the new combination.

Key to Species in Section Cyclocheila

1. Thallus isidiate or pustulate.
   2. Thallus distinctly pustulate; soredia absent or only sparsely developed.
      3. Thallus corticolous; lobes rather broad, 2–5 mm. wide.
         4. Medulla P− (divaricatic acid) . . . . . **4. P. eruptens** Kurokawa
         4. Medulla P+ red (protocetraric acid) . . . . . **P. raunkiaeri** Vain.
      3. Thallus saxicolous; lobes narrow, to 1 mm. wide.
         5. Medulla P+ red (unknown) . . . . . **6. P. imperfecta** Kurokawa
         5. Medulla P−.

6. Caperatic acid present . . . . . **8. P. pustulescens** Kurokawa
6. Divaricatic acid present . . . . . **P. owariensis** Asah.
2. Thallus with cylindrical isidia.
7. Lower surface pale brown.
8. Medulla pale yellow . . . . . **P. cyphellata** (Lynge) Sant.
8. Medulla white.
9. Lobes broad, 2–5 mm. wide; subrotund . . **9. P. salacinifera** Hale
9. Lobes narrow, 0.5–2.0 mm. wide, sublinear.
10. Thallus mineral gray, usnic acid lacking . **2. P. arcana** Kurokawa
10. Thallus yellowish green (usnic acid).
11. Lobes 1.5–2.0 mm. wide; rhizines black.
P. abstrusoides des Abb.
11. Lobes 0.5–1.5 mm. wide; rhizines mostly pale.
12. Medulla P−, KC+ orange (barbatic acid).
P. rahengensis Vain.
12. Medulla P+ red (protocetraric acid) . . **P. malaccensis** Nyl.
7. Lower surface jet black.
13. Thallus yellowish green (usnic acid) . . . . **P. ecaperata** Müll. Arg.
13. Thallus mineral gray (usnic acid lacking).
14. Thallus saxicolous.
15. Medulla C+ deep red (lecanoric acid) . **1. P. annexa** Kurokawa
15. Medulla C−, P+ pale orange (stictic acid).
7. P. ischnoides Kurokawa
14. Thallus corticolous.
16. Medulla P+ orange red.
17. Medulla K+ red (salacinic acid) . . . . **P. cinerascens** Lynge
17. Medulla K− or brownish (protocetraric acid).
18. Isidia rather irregular, often becoming granular.
P. martinicana Nyl.
18. Isidia cylindrical, normal . . . . . **P. amazonica** Nyl.
16. Medulla P−.
19. Upper cortex finely cracked; perlatolic acid present.
P. caroliniana Nyl.
19. Upper cortex continuous or irregularly cracked with age.
20. Lobes subrotund, 2–5 mm. wide; KC+red unknown present.
P. meiosperma (Hue) Dodge
20. Lobes sublinear, 1.5–2.0 mm. wide; divaricatic acid present.
P. concrescens Vain.
1. Thallus lacking pustules or isidia.
21. Thallus sorediate.
22. Thallus yellowish green (usnic acid).
23. Medulla K+red (salacinic acid); soredia farinose . **P. soredians** Nyl.
23. Medulla K− (protocetraric acid); soredia coarse, originating from pustules . . . . . **P. caperata** (L.) Ach.
22. Thallus mineral gray (usnic acid lacking).
24. Upper cortex reticulately ridged and wrinkled; stictic acid present.
25. Lobes subrotund, 2–5 mm. wide . . . **P. crozalsiana** B. de Lesd.
25. Lobes sublinear, 1.0–2.5 mm. wide . . **P. carneopruinata** Zahlbr.
24. Upper cortex plane, not ridged.
26. Soredia strongly capitate, submarginal.
P. cryptochlorophaea Hale
26. Soredia laminal, not strongly capitate.

27. Yellowish pigment present under soralia; KC+ unknown present . . . . . **P. aptata** Kremplh.
27. Pigments absent; divaricatic acid present . . . **P. texana** Tuck.

21. Thallus lacking soredia.
28. Lower surface pale to dark brown.
29. Medulla pigmented, the pigment K+ purple black.
30. Pigment present throughout the medulla.
11. P. violacea Kurokawa
30. Pigment present only in lower half of the medulla.
P. hypomilta Fée
29. Medulla white or pale yellow, the pigment K−.
31. Medulla pale yellow.
32. Thallus saxicolous; lobes 1 mm. wide or less.
P. chapadensis Lynge
32. Thallus corticolous; lobes 2–5 mm. wide . **P. sphaerospora** Nyl.
31. Medulla white, without any pigments.
33. Thallus corticolous; medulla P+ orange red (protocetraric acid).
34. Usnic acid present . . . . **P. intertexta** Mont. & v.d. Bosch.
34. Usnic acid absent.
35. Spores 5–7×8–11 μ; Africa . . . **P. somaliensis** Müll. Arg.
35. Spores 14–18×26–28 μ; South America.
P. leucopis Kremplh.
33. Thallus saxicolous; medulla P−.
36. Medulla C+ deep red (lecanoric acid) . . **P. molybdiza** Nyl.
36. Medulla C− . . . . . **10. P. tortula** Kurokawa
28. Lower surface jet black.
37. Medulla pigmented, the pigment K+ purple black.
38. Thallus yellowish green (usnic acid) . . **P. rutidota** Hook. & Tayl.
38. Thallus mineral gray (usnic acid lacking).
39. Thallus saxicolous, the lobes subareolate, appressed.
P. lecanoracea Müll. Arg.
39. Thallus corticolous, the lobes loosely adnate.
5. P. heterochroa Hale & Kurokawa
37. Medulla white; pigments absent.
40. Thallus saxicolous.
41. Lobes appressed to the substratum.
42. Medulla C+ red (lecanoric acid) . . . . . **P. molybdiza** Nyl.
42. Medulla C−.
43. Medulla K+ yellow (stictic acid).
P. xanthomelaena Müll. Arg.
43. Medulla K− (divaricatic acid) . . . . . **P. rupicola** Lynge
41. Lobes loosely adnate.
44. Medulla P+ red (protocetraric acid) . . . **3. P. caribaea** Hale
44. Medulla P− (divaricatic acid) . . . . **P. rodriguesiana** Hue
40. Thallus corticolous.
45. Thallus yellowish green (usnic acid) . **P. rutidota** Hook. & Tayl.
45. Thallus mineral gray (usnic acid lacking).
46. Medulla K+ yellow (stictic acid); upper cortex reticulately ridged . . . . . **P. scrobicularis** Kremplh.
46. Medulla K−; upper cortex plane . . . . . **P. subtiliacea** Nyl.

1. Parmelia annexa Kurokawa, sp. nov. PLATE 4

Thallus arcte adnatus, saxicola, albido-cinerascens, 3–7 cm. latus, lobis sublinearibus, centrum versus subimbricatis, 0.7–3.5 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiatus, subtus niger sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1.5–5.0 mm. diametro; hymenium 70–80 μ altum; sporae 5×7–8 μ.

Thallus tightly adnate on rock, pale olive gray to light mineral gray (R), 3–7 cm. in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate towards the center, 0.7–3.5 mm. wide, 180–240 μ thick, the margins crenate; upper surface plane, shiny, not maculate, irregularly cracked with age, isidiate, the isidia cylindrical, mostly simple, darkening at the tips, about 0.2 mm. high; medulla white; undersurface black, sparsely rhizinate, the rhizines black, simple. Apothecia adnate, 1.5–5.0 mm. in diameter, exciple undulate, amphithecium isidiate, disc snuff brown (R); hymenium 70–80 μ high; spores 5×7–8 μ.

Reactions: Thallus K+ yellow; medulla K−, C+ deep red, KC+ red, P−, atranorine and lecanoric acid present.

Type in the Botanical Museum, Lund University, collected at Mossel River, 3 miles east of Hermanus, Caledon, Cape Province, Union of South Africa, Sept. 29, 1953, by Ove Almborn (no. 5683; isotype in US).

This is a typical South African saxicolous lichen clearly related to *P. molybdiza* Nyl., the only other species of the section *Cyclocheila* with lecanoric acid. *Parmelia molybdiza* differs in lacking isidia and in having a pale brown, rarely black, undersurface. Both species grow tightly adnate on exposed acidic rocks over a wide area in southern Africa.

Additional specimens examined: Angola: Malanje: Between Benguela and Coporolo, *Degelius*, Feb. 2, 1960 (DEGEL), Duque de Braganca, *Degelius*, Mar. 5, 1960 (DEGEL, US). Union of South Africa: Natal: 8 miles south of Lomkile, Nongoma Distr., *Höeg*, August 1929 (TRH); Cape Province: Cape Town, *Höeg*, May 31, 1929 (TRH). Mossel River, Caledon Distr., *Almborn* 5701 (LD), Camps Bay, Cape Distr., *Almborn* 4402 (LD).

2. Parmelia arcana Kurokawa, sp. nov. PLATE 4

Thallus arcte adnatus, saxicola, albido-cinerascens, 3–7 cm. latus, lobis sublinearibus, 0.3–1.0 mm. latis, margine subcrenatis, superne nitidus, emaculatus, isidiatus, medulla pro parte pallide flavescens, subtus castaneus, sparse rhizinosus, rhizinis castaneis, simplicibus. Apothecia ignota.

Thallus tightly adnate on rock, pale to dark olive gray (R), 3–7 cm. in diameter; lobes dichotomously or irregularly branched, sublinear-

elongate, areolate toward the center, 0.3–1.0 mm. wide, 100–150 μ thick, the margins more or less crenate; upper surface plane to convex rather shiny, not maculate, tangentially cracked on older lobes isidiate, the isidia cylindrical, mostly simple, about 0.2 mm. high; medulla white, partly pale yellow in the upper half; undersurface brown to pale brown, sparsely rhizinate, the rhizines brown, simple. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, pigment if present K−, atranorine, an unidentified fatty acid, and an unidentified pale yellow pigment present.

Type in the herbarium of G. Degelius, collected in desert northeast of Baba, Mocâmedes, Angola, Feb. 5, 1960, by G. Degelius (isotype in US).

Parmelia arcana is a tightly adnate saxicolous species with the same habit and lobe configuration as *P. annexa* Kurokawa and *P. molybdiza* Nyl. These latter two species contain lecanoric acid. The pale undersurface of *P. molybdiza* is reminiscent of *P. arcana*, and the isidia of *P. annexa* are similar to those of *P. arcana* except that they are generally more papillate.

Additional specimen examined: Union of South Africa: Koningskroon, Elliott Distr., Cape Prov., *Höeg*, Dec. 1, 1929 (TRH).

3. Parmelia caribaea Hale, sp. nov. PLATE 3

Thallus adnatus, eborinus vel cinereo-albicans, saxicola, 6–10 cm. diametro, lobis parum lobatis, irregulariter sublinearibus, subimbricatis, margine integris, superne planus, demum rugosus, sorediis isidiisque destitutus, subtus niger, modice rhizinosus, rhizinis crassis, nigris, simplicibus, ambitu fusco-castaneus, anguste nudus vel papillatus. Apothecia subpedicellata, urceolata, usque ad 5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5×10–13 μ.

Thallus adnate, saxicolous, ivory to whitish gray, 6–10 cm. wide, rather coriaceous; lobes irregularly sublinear, infrequently branched, more or less imbricate, 3–6 mm. wide, 200–250 μ, the margins entire to undulate, more or less black-rimmed, soredia and isidia lacking; upper surface plane, rugulose with age, cracked on older lobes; medulla white; undersurface black, moderately rhizinate, the rhizines thick, simple, the marginal zone brown, narrowly naked or papillate. Apothecia subpedicellate, at first globose, urceolate at maturity, up to 5 mm. in diameter, amphithecium rugose, the disc imperforate; hymenium 50–60 μ high; spores 4–5×10–13 μ.

Reactions: Thallus K+ yellow; medulla K−, KC+ rose, C−, P+ orange red, atranorine and protocetraric acid present.

Type in the Missouri Botanical Garden, collected at Flanc Nord, Morne de Villet, St. Barthelemy, West Indies, Oct. 23, 1952, by C. Le Gallo (no. 494; isotype in US).

This remarkable species has been collected only on the island of St. Barthelemy. It is a saxicolous lichen without any obvious affinities. The mode of branching and the undersurface resemble *P. nairobiensis* Stein. & Zahlbr. and related South African species that contain divaricatic acid. *Parmelia caribaea* also has the black-rimmed margins typical of these species but the upper surface lacks any distinct white-netted reticulation. The apothecia are peculiar in that the disc may remain closed until quite late in the development of apothecia, so that young apothecia appear like spherical buds.

Additional specimens examined: St. Barthelemy: Saline, *Le Gallo* 491 (MO, US); Morne de Villet, *Le Gallo* 473 (MO, US); without specific locality, *Le Gallo* 2604 (MSC).

4. Parmelia eruptens Kurokawa, sp. nov. PLATE 3

Thallus adnatus, corticola, olivaceo-albicans, 5–8 cm. diametro, lobis subirregularibus, 2–8 mm. latis, margine crenatis, superne emaculatus, isidiatus, isidiis crassis, inflatis, apice demum pustulescentibus, subtus niger, sparse rhizinosus, ambitu castaneus, subnudus, rhizinis nigricans, simplicibus. Apothecia adnata, 1–3 mm. diametro; hymenium 90–100 μ altum; sporae 5–7$\times$10–12 μ.

Thallus adnate on bark, marguerite yellow to olive buff (R), 5–8 cm. in diameter; lobes irregularly branched, subrotund, 2–8 mm. wide, 190–240 μ thick, the margins crenate, dark brown-rimmed near the tips; upper surface smooth and shiny, without maculae, moderately to densely isidiate, the isidia irregularly inflated, narrower at the base, at length breaking open at the tips; medulla white; undersurface black, brown and naked in a narrow zone near the tips, sparsely rhizinate, the rhizines pale near the margins, blackening at the center, simple. Apothecia adnate, 1–3 mm. in diameter, exciple more or less crenate, amphithecium isidiate, disc vandyke brown (R); hymenium 90–100 μ high; spores 5–7$\times$10–12 μ.

Reactions: Thallus K+ yellow; medulla K—, C—, KC—or KC + fleeting purple violet, P—, atranorine and divaricatic acid present.

Type in the Botanical Museum, Lund University, collected 5 miles east of Mokobulaan, Lydenburg, Transvaal, Union of South Africa, Oct. 21, 1953, by Ove Almborn (no. 7498; isotype in US).

Parmelia eruptens is characterized by rather large subirregular lobes and unusually large pustules which break open apically without soredial formation. It has much broader and more loosely attached lobes than other corticolous species containing divaricatic acid, such as *P. nairobiensis* Stein. & Zahlbr. and *P. texana* Tuck., though it is obviously related to these species. *Parmelia eruptens* is apparently endemic to South Africa.

Additional specimens examined: Union of South Africa: Transvaal: Mount Anderson, Sabie-Lydenburg, *Maas Geesteranus* 6453 (L, US),

6455 (L); Moçambique: Near Rock Pueshang, west of Martins Falls, Manica and Sofala distrs., *Mitchell* 332 (US).

5. Parmelia heterochroa Hale & Kurokawa, nom. nov.

Parmelia hypoxantha Stirt. Trans. New Zealand Inst. 32:76. 1899. Type collection: Warwick, Queensland, Australia, *Gwyther* s.n. (BM, holotype). Non *P. hypoxantha* Müll. Arg. Flora 64:85. 1881 (= *Chondropsis semiviridis* Nyl.).

Parmelia tiliacea (Hoffm.) Ach. var. *stenophylla* Müll. Arg. Flora 66:46. 1883. Type collection: Toowoomba, Queensland, Australia, *Hartmann* s.n. (G, holotype).

P. tiliacea var. *rugulata* Müll. Arg. Nuov. Giorn. Bot. Ital. 23:388. 1891. Type collection: Brisbane, Australia, *Bailey* s.n. (G, lectotype).

P. tiliacea var. *convexula* Müll. Arg. Bull. Herb. Boiss. 4:90. 1896. Type collection: Brisbane, Australia, *Shirley* 1665 (G, holotype) [collector on label given as Bailey].

Type collection: Warwick, Queensland, Australia, *Gwyther* s.n. (BM).

Thallus adnate, mineral gray, turning olive buff in the herbarium, 4–12 cm. in diameter; lobes more or less dichotomously branched, sublinear-elongate, 1–4 mm. wide, 160–210 μ thick, the margins more or less crenate, often black-rimmed near the tips; upper surface plane to convex, smooth, shiny, irregularly rugose and cracked on older lobes, isidia and soredia lacking; medulla white above, capucine buff to zinc orange in the lower half; undersurface black, moderately to densely rhizinate, the rhizines black, simple, irregularly to squarrosely branched, 0.5–1.7 mm. long. Apothecia adnate, 1–5 mm. in diameter, exciple smooth to crenate or undulate, disc imperforate; hymenium 70–80 μ high; spores 7–8$\times$10–12 μ, episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ rose, P+ orange red, pigment K+ purple, atranorine, protocetraric acid, and an unidentified anthraquinone pigment present.

This remarkable species is known only from Queensland, Australia, where it appears to be common. Superficially, it resembles *P. livida* Tayl. or even *P. brasiliana* Nyl. but the lower medulla is conspicuously pigmented. The rhizines are mostly simple, though occasionally squarrosely branched. It is the only species outside of section *Parmelia* and section Irregulares that has squarrose rhizines, but it is clearly unrelated to these two sections. On a gross morphological basis we would prefer to put *P. heterochroa* in section *Hypotrachyna* but the peculiar rhizines indicate a closer affinity to section *Cyclocheila*.

Additional specimens examined: Australia: Toowoomba, Queensland, *Hartmann* 45 (G) (syntype of *P. tiliacea* var. *rugulata*); Queensland, *Bailey* 334 (BM).

6. Parmelia imperfecta Kurokawa, sp. nov.

Thallus arcte adnatus, saxicola, albido-cinerascens, 2–4 cm. diametro, lobis sublinearibus, 0.5–2.0 mm. latis, margine crenatis, superne nitidus, isidiato-pustulatus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia ignota.

Thallus closely or loosely adnate on rock, pale gull gray to light mineral gray (R), 2–4 cm. in diameter; lobes irregularly branched, sublinear-elongate, 0.5–2.0 mm. wide, 120–170 μ thick, the margins crenate; upper surface plane to more or less concave, shiny, irregularly cracked on older lobes, isidiate-pustulate, the pustules short, erupting; medulla white; undersurface black, sparsely rhizinate, the rhizines simple, about 0.2 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K− or K+ yellowish, C−, KC−, P+ orange red, atranorine and an unknown P+ substance (forming small balls in G. A. o–T.) present.

Type in the Botanical Museum, Lund University, collected at the Cathedral Peak Area, Bergville, Natal, Union of South Africa, Nov. 2, 1953, by Ove Almborn (no. 8815; isotype in US).

Parmelia imperfecta is another saxicolous lichen endemic to South Africa. It is apparently related to *P. annexa* Kurokawa, *P. arcana* Kurokawa, and *P. molybdiza* Nyl. The pustules are rather sparse, thick and short and burst open apically without formation of soredia. Almost identical pustules are found in the saxicolous Japanese species *P. ovariensis* Asah., which differs principally in containing divaricatic acid.

Additional specimens examined: Union of South Africa: Transvaal: Punch Bowl Inn, north of Louis Trichardt, *Almborn* 6491 (LD); Louis Trichardt, near Punch Bowl, Zoutpansberg, *Almborn* 6108 (LD, US).

7. Parmelia ischnoides Kurokawa, sp. nov. PLATE 4

Thallus arcte adnatus, saxicola, cinereo-albicans, 4–10 cm. latus, lobis sublinearibus, 0.5–2.0 mm. latis, superne nitidus, emaculatus, isidiatus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 1–2 mm. diametro; hymenium 70–80 μ altum; sporae 5–6$\times$7–8 μ.

Thallus closely adnate on rock, pearl gray to mineral gray (R), 4–10 cm. in diameter; lobes irregularly branched, sublinear-elongate, more or less imbricate with age, 0.5–2.0 mm. wide, 200–280 μ thick, the margins entire to subcrenate; upper surface plane to convex, shiny, not maculate, isidiate, the isidia cylindrical, short and simple, darkening apically; medulla white; undersurface black, sparsely rhizinate, the rhizines black, simple. Apothecia adnate, 1–2 mm.

in diameter, exciple more or less crenate, amphithecium isidiate, disc light seal brown (R); hymenium 70–80 μ high; spores 5–6×7–8 μ.

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange, atranorine and stictic acid present.

Type in the Botanical Museum, Lund University, collected on rocks near Window Stream, Kirstenbosch, Wynberg, Cape Province, Union of South Africa, Aug. 3, 1953, by Ove Almborn (no. 1698; isotype in US).

Parmelia ischnoides adds still another member to that unique group of saxicolous species so common in the Cape region (see discussions under *P. annexa* and *P. imperfecta*). It is characterized by adnate, linear and more or less separate lobes as illustrated in plate 4 to broad and more crowded lobes up to 2 mm. wide. Isidia are often quite dense but always rather small or even at times papillate. The chemical component, stictic acid, is quite rare in the section *Cyclocheila*.

Additional specimens examined: Union of South Africa: Cape Province: Kirstenbosch, Wynberg Distr., *Almborn* 124, 1443 (LD); Window Gorge, Wynberg Distr., *Almborn* 788 (LD); near Kloof Neck, Camps Bay Road, Cape Distr., *Almborn* 864 (LD).

8. Parmelia pustulescens Kurokawa, sp. nov. PLATE 4

Thallus arcte adnatus, saxicola, albido-cinerascens, 3–5 cm. latus, lobis sublinearibus, 0.3–1.2 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiatus, isidiis irregulariter inflatis, demum apice pustulescentibus, subtus niger, sparse rhizinosus, rhizinis nigris, simplicibus. Apothecia adnata, 0.7–2.0 mm. diametro; hymenium 45–55 μ altum; sporae 4–5×7–9 μ.

Thallus tightly adnate on rock, pearl gray to light mineral gray (R), 3–5 cm. in diameter; lobes dichotomously to irregularly branched, sublinear-elongate, 0.3–1.2 mm. wide, 100–130 μ thick, the margins crenate, narrowly black-rimmed near the tips; upper surface plane and shiny, without maculae, irregularly cracked on older lobes, isidiate, the isidia cylindrical, irregularly inflated, at length bursting open apically; medulla white; undersurface black, sparsely rhizinate, the rhizines simple, black, 0.1–0.2 mm. long. Apothecia adnate, 0.7–2.0 mm. in diameter, exciple isidiate-pustulate, disc clove brown (R); hymenium 45–55 μ high; spores 4–5×7–9 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and caperatic acid present.

Type in the herbarium of G. Degelius, collected near Fazenda Canjangue, Vila Flor, Humbo, Angola, Feb. 18, 1960, by G. Degelius (isotype in US).

Parmelia pustulescens is an adnate saxicolous lichen virtually indistinguishable from *P. imperfecta* Kurokawa and *P. owariensis* Asah.

in the development of pustules. (See discussion under *P. imperfecta*.) *Parmelia pustulescens* differs chiefly in containing caperatic acid. It is known only from the type specimen.

9. Parmelia salacinifera Hale, sp. nov. PLATE 9

Thallus adnatus, corticola, olivaceo-albicans, 6–12 cm. diametro, lobis subirregularibus, subrotundatis, 3–6 mm. latis, 170–190 μ crassis, superne planus, nitidus, modice isidiatus, subtus pallide castaneus, modice rhizinosus, rhizinis concoloribus, simplicibus, ambitu anguste nudus vel papillatus. Apothecia adnata, 2–4 mm. diametro; hymenium 30–38 μ altum; sporae non evolutae.

Thallus adnate, corticolous, olivaceous to mineral gray, 6–12 cm, in diameter; lobes subirregular, 3–6 mm. wide, 170–190 μ thick, apically subrotund, the margins entire to subcrenate; upper surface plane, rugose and fissured with age, shiny, moderately isidiate, the isidia cylindrical, usually simple, 0.04–0.08×0.16–0.30 mm.; undersurface pale brown, moderately rhizinate, the rhizines pale brown, simple, the marginal zone bare or papillate. Apothecia adnate, 2–4 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 30–38 μ high; spores not developed.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Type in the U.S. National Herbarium, collected at Sanford, Seminole County, Florida, March 1925, by S. Rapp (isotype in FLAS).

Parmelia salacinifera is a typical member of section *Cyclocheila* with irregular subrotund lobes. The thallus is usually quite closely adnate on bark. At first glance it seems indistinguishable from *P. amazonica* Nyl., which occurs from Florida to Brazil; *P. amazonica* has a jet black undersurface and protocetraric acid. *Parmelia salacinifera* undoubtedly occurs generally in the Caribbean region. A typical habitat is burned palm trunks in pastures.

Additional specimens examined: Georgia: 5 mi. SW. of Waycross, Ware Co., *Hale* 16843 (US). Florida: Tomoka State Forest, Volusia Co., *Hale* 17063 (US); near Pensacola, Escambia Co., *Hale* 7994 (US); Dog Lake Recreation Area, *Hale*, 16714 (US); 6 mi. SW. of Tallahassee, Leon Co., *Hale* 16984 (US); Orange Park, Clay Co., *Hale* 17735 (US); vicinity of Fort Myers, Lee Co., *Standley* 13084 (US); Sanford, Seminole Co., *Rapp* 472, May 1919, February 1924 (FLAS). Mexico: Km. 956 on Hwy. 190, west of Ocozocoautla, Chiapas, *Hale* 20607 (US). Brazil: Mato Grosso: Bocca da Serra, *Malme* s.n. (UPS).

10. Parmelia tortula Kurokawa, sp. nov. PLATE 4

Thallus adpressus, saxicola, albido-cinerascens, 5–10 cm. latus, lobis subirregularibus vel sublinearibus, apice subrotundatus, 1.5–4.0 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiis

sorediisque destitutus, subtus pallide castaneus, sparse rhizinosus, rhizinis castaneis, simplicibus. Apothecia adnata vel substipitata, 1–5 mm. diametro; hymenium 40–50 μ altum; sporae 5–6$\times$7–9 μ.

Thallus closely adnate on rock, yellowish glaucous to light olive gray (R), 5–10 cm. in diameter; lobes irregularly branched, subirregular to sublinear-elongate, more or less subrotund apically, often twisted and contorted, 1.5–4.0 mm. wide, 180–220 μ thick, the margins entire to crenate, black-rimmed at the tips; upper surface shiny, often faintly pruinose, without maculae, rugulose and distinctly cracked on older lobes, isidia and soredia lacking; medulla white; undersurface pale brown, sparsely rhizinate, the rhizines simple, pale brown, about 0.3 mm. long. Apothecia adnate to substipitate, 1–5 mm. in diameter, exciple and amphithecium smooth, disc bone brown (R); hymenium 40–50 μ high; spores 5–6$\times$7–9 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, or KC+ faint rose, P−, atranorine and unknown colorless substances present.

Type in the Botanical Museum, Lund University, collected on rocks between O'okiep and Springbok, Namaqualand, Cape Province, Union of South Africa, Sep. 15, 1953, by Ove Almborn (no. 4805; isotype in US).

Parmelia tortula is a saxicolous species common in the Cape region and obviously related to *P. molybdiza* Nyl. Generally it is larger and the colonies more extensive than in *P. molybdiza*. The lobes are often more or less twisted and, at least near the tips, partially free of the substratum; *P. molybdiza* is less robust and contains lecanoric acid. The chemistry of *P. tortula* is not entirely clear at this time. The KC+ test is variable, often weak or absent. Microchemical tests have not revealed the cause of this reaction.

Additional specimens examined: Union of South Africa: Orange Free State: Thabanchis, *Höeg*, Aug. 12, 1929 (TRH); Cape Province: 4 miles south-southwest of Oudtshoorn, Oudtshoorn Distr., *Almborn* 4199 (LD); Saldanha, Malmesbury Distr., *Almborn* 4988, 4996 (LD); Sea Point, Cape Town, Wynberg Distr., *Höeg*, May 31, 1929 (TRH); Dordricht, *Höeg*, Nov. 21, 1929 (TRH).

11. Parmelia violacea Kurokawa, **sp. nov.**

Thallus adpressus vel adnatus, saxicola, olivaceo vel viridi-cinerascens, 3–6 cm. diametro, lobis sublinearibus, 1–3 mm. latis, margine crenatis, superne nitidus, emaculatus, isidiis sorediisque destitutus, medulla purpureus, subtus pallide castaneus, modice rhizinosus, rhizinis castaneis, simplicibus. Apothecia adnata, 1.0–1.5 mm. diametro; sporis non visis.

Thallus closely adnate on rock, smoke gray to dark olive gray (R), 3–6 cm. in diameter; lobes irregularly branched, sublinear-elongate, 1–3 mm. wide, 160–200 μ thick, the margins crenate; upper surface shiny, without maculae, distinctly rugulose on older lobes, isidia and soredia lacking; medulla vinaceous purple to indian purple (R); undersurface pale brown, moderately rhizinate, the rhizines pale brown, simple, 0.5–1.0 mm. long. Apothecia adnate, 1.0–1.5 mm. in diameter, exciple and amphithecium smooth, disc cameo brown to vandyke brown (R); mature spores not seen.

Reactions: Thallus K+ yellow; medulla K+ deep purple, P—, atranorine and an unidentified hydroxanthraquinone present.

Type in the Botanical Museum, Lund University, collected at Blinkwater Ravine, slopes of Table Mountain, Cape Province, Union of South Africa, Aug. 5, 1953, by Ove Almborn (no. 1771; isotype in US).

Parmelia violacea has a brilliant deep rusty-red medulla, frequently exposed as the upper cortex breaks away. In this respect it is very similar to *P. endomiltoides* Nyl., a *Xanthoparmelia* species with usnic acid and two unidentified pigments, one of them (of lower R_f) identical with that in *P. violacea*. Both of these species are found on Table Mountain in Cape Province.

5. Section *Hypotrachyna* Vain. (1890, p. 38)

Section *Hypotrachyna* Sublinearis* Vain. (1890, p. 50).
Section *Sublineares* (Vain.) Vain. (1923, p. 34).
Section *Hypotrachyna* subsection *Sublineares* (Vain.) Gyel. (1932, p. 223).
Section *Hypotrachyna* subsection *Sublineares* (Vain.) Hillm. (1934, p. 187).
Superfluous combination.

Type species: *Parmelia brasiliana* Nyl.

Thallus adnate to loosely attached and subdivaricate; lobes sublinear to linear-elongate; lower surface jet black, the rhizines more or less richly dichotomously branched.

The type species of this section should be selected from the Brazilian species cited in Vainio's original study. We believe that he considered his group *Sublinearis* to represent the typical concept of section *Hypotrachyna* and *P. brasiliana* Nyl. to be a typical species in this group. Two other groups described at the same time, *Cyclocheila* (= section *Cyclocheila* (Vain.) Räs.) and *Irregularis* (= section *Irregulares* (Vain.) Vain.), were described as having subirregular rotund lobes with a narrow bare zone below. In his study of Philippine lichens, Vainio (1923) put the subirregular species into a new section (*Irregulares*) and the sublinear species into section *Sublineares* (Vain.) Vain. He included *Parmelia americana* (Mey. & Flot.) Mont. and *P. sorocheila*

Vain. in section *Sublineares*, but these are everniiform species that should be transferred to the genus *Pseudevernia* Zopf.

As we have delimited section *Hypotrachyna*, it does not include *P. saxatilis* (L.) Ach., the type of section *Parmelia*, which has pseudocyphellae and squarrosely branched rhizines. For this reason, section *Parmelia*, which includes *P. saxatilis*, and section *Hypotrachyna* cannot be considered as synonymous.

Section *Hypotrachyna* is the largest yet surprisingly the most homogeneous group of species in subgenus *Parmelia*. All species have a black lower surface with more or less distinctly dichotomously branched rhizines, sometimes so dense as to form a marginal mat projecting beyond the margins. Cilia are absent, although projecting branched rhizines might be mistaken for cilia. The greatest concentration of species is in tropical America, where 48 of the 83 species are endemic. Fourteen species are endemic to Asia and only six to Africa.

Morphological and chemical diversity reach a peak in this section. There is an abundance of sorediate species (14). There are a number of acids not found in any of the other sections of subgenus *Parmelia* except section *Cyclocheila* (cf. table 1). These include alectoronic acid, barbatic acid, divaricatic acid, evernic acid, lichexanthone, olivetoric acid, and perlatolic acid. All of these substances are negative with KOH, paraphenylenediamine, calcium hypochlorite (except for olivetoric acid), and most are KC+ red and more or less fluorescent in ultraviolet light. In addition, if depsides, they have a basic 2-methoxy substitution on the acid ring (cf. Asahina and Shibata, 1954, p. 54), whereas the other depsides usually have a 2-hydroxy substitution. The full significance of this chemical variation has not yet been assessed, but the overall correlation between the chemical constituents and our sectional classification appears to be sound.

Key to Species in Section Hypotrachyna Vain.

1. Thallus isidiate . . . . . I.
1. Thallus lacking isidia.
   2. Thallus sorediate or pustulate . . . . . II. (p. 161).
   2. Thallus lacking isidia, soredia, or pustules . . . . . III. (p. 163).

I. THALLUS ISIDIATE

1. Medulla yellow, the pigment K−.
   2. Medulla C−; isidia dense . . . . . **P. isidiocera** Nyl.
   2. Medulla C+ red (unknown); isidia variable, sparse, simple to coralloid. **23. P. prolongata** Kurokawa
1. Medulla white, or if pigmented, the pigment K+ purple.
   3. Upper cortex distinctly maculate.
      4. Medulla K−, C−, KC−, P− (fatty acids) . . . **P. costaricensis** Nyl.

4. Medulla P+ yellow to red or KC+ red or orange.
5. Medulla K+ yellow, P+ yellow (unknown).
9. P. dentella Hale & Kurokawa
5. Medulla K−, KC+ red or orange.
6. Medulla C−, KC+ orange (barbatic acid).
7. Isidia cylindrical . . . . . **P. imbricatula** Zahlbr.
7. Isidia lobulate, dorsiventral . . . . . **P. digitata** Lynge
6. Medulla C−, KC+ rose (evernic acid).
8. Isidia cylindrical . . . . . **P. bogotensis** Vain.
8. Isidia lobulate, dorsiventral . . . . . **P. culmigena** Zahlbr.

3. Upper cortex not distinctly maculate.
9. Medulla P+ yellow to orange red.
10. Medulla K− (protocetraric acid).
11. Medulla ochraceous yellow in the lower half . **P. consimilis** Vain.
11. Medulla entirely white . . . . . **P. koyaensis** Asah.
10. Medulla K+ yellow or red.
12. Thallus yellowish green (usnic acid); norstictic acid present.
P. microblasta Vain.
12. Thallus grayish green (usnic acid lacking).
13. Rhizines finely branched; isidia mostly simple; norstictic acid present . . . . . **24. P. rhabdiformis** Kurokawa
13. Rhizines sparsely to moderately branched; isidia often branched; stictic acid present . . . . . **5. P. crenata** Kurokawa

9. Medulla P−.
14. Medulla C+ red or yellow or KC+ red or orange.
15. Medulla C+ deep red, KC+ red (unknown).
23. P. prolongata Kurokawa
15. Medulla C− or C+ yellow, KC+ orange (barbatic acid).
16. Isidia cylindrical . . . . . **P. imbricatula** Zahlbr.
16. Isidia lobulate, dorsiventral . . . . . **P. digitata** Lynge
14. Medulla C−, KC−, or KC+ red.
17. Medulla KC+ red or rosy.
18. Isidia inflated or pustular; medulla usually ochraceous yellow under the isidia . . . . . **P. dactylifera** Vain.
18. Isidia simple or lobulate; pigments absent.
19. Isidia lobulate, dorsiventral; alectoronic acid present.
10. P. ensifolia Kurokawa
19. Isidia cylindrical; KC+ unknown present.
P. nodakensis Asah.
17. Medulla C−, KC−; fatty acids present.
20. Upper cortex weakly maculate; rhizines densely branched; America . . . . . **P. costaricensis** Nyl.
20. Upper cortex without maculae; rhizines moderately branched; Asia.
18. P. infirma Kurokawa

II. THALLUS SOREDIATE OR PUSTULATE

1. Pustules distinct, without soredia or only very sparsely sorediate.
2. Thallus yellowish green (usnic acid) . . . . . **P. meyeri** Zahlbr.
2. Thallus mineral gray (usnic acid lacking).
3. Medulla pale yellow orange, pigment K− . . . **P. endochlora** Leight.
3. Medulla white or in part pigmented, pigment K+ purple.
4. Pigments present, K+ purple.

5. Thallus 2–4 cm. broad, the lobes up to 1 mm. wide . **P. malmei** Lynge
5. Thallus 3–10 cm. broad, the lobes 1.0–2.5 mm. wide.
P. formosana Zahlbr.

4. Pigments absent.
6. Medulla C+ rose (gyrophoric acid) . . . . . **P. revoluta** Floerke
6. Medulla C−, KC+ orange (barbatic acid).
7. Pustules distinct, becoming sorediate; Asia . . . **P. exsecta** Tayl.
7. Pustules irregular, esorediate; cortex fragile; North America.
29. P. virginica Hale

1. Pustules indistinct or absent; soredia usually abundant, farinose.
8. Upper cortex distinctly maculate.
9. Medulla pale yellow orange throughout . . . . **P. endochlora** Leight.
9. Medulla white.
10. Medulla KC+ orange (barbatic acid) . . **P. laevigata** (Sm.) Ach.
10. Medulla KC+ red or rose.
11. Evernic acid present . . . . . **P. rockii** Zahlbr.
11. Alectoronic acid present . . . . . **13. P. exsplendens** Hale
8. Upper cortex without maculae or at most in part faintly maculate.
12. Thallus yellowish green (usnic acid).
13. Medulla K+ yellow turning red (salacinic acid).
P. sinuosa (Sm.) Ach.
13. Medulla K−, P+ orange red (protocetraric acid).
14. Soralia mainly terminal; medulla ochraceous (rhodophyscin) under the soralia . . . . . **P. velloziae** Vain.
14. Soralia mainly subterminal; pigments lacking.
15. P. flavovirens Kurokawa
12. Thallus mineral gray (usnic acid lacking).
15. Medulla P+ yellow to orange red.
16. Medulla K+ yellow turning to red (salacinic acid).
17. Rhizines moderately branched; zeorine present.
P. majoris Vain.
17. Rhizines finely branched; zeorine absent.
2. P. brevirhiza Kurokawa
16. Medulla K−.
18. Lichexanthone present; P+ unknown present.
P. subaffinis Zahlbr.
18. Lichexanthone absent; protocetraric acid present.
19. Orange-red pigment (rhodophyscin) under the soralia.
6. P. croceopustulata Kurokawa
19. Pigments absent under the soralia.
20. Lobes 1.5–2.0 mm. wide; soralia mostly subterminal.
P. pseudosinuosa Asah.
20. Lobes 0.5–1.0 mm. wide; soralia mostly laminal.
1. P. anaptychioides Kurokawa
15. Medulla P−.
21. Orange-yellow pigment (rhodophyscin) under the soralia.
19. P. leiophylla Kurokawa
21. Pigments absent.
22. Medulla C+ rose, red, or orange red.
23. Medulla C+ red or orange red (olivetoric acid).
21. P. lividescens Kurokawa
23. Medulla C+ rose (gyrophoric acid).

24. Lobes linear-elongate, subdivaricate; Mexico.
28. P. thysanota Kurokawa
24. Lobes loosely adnate, sublinear; Africa . . **P. revoluta** Flk.
22. Medulla C−, KC+ red or orange red.
25. Medulla KC+ orange (barbatic acid) . . . **P. rockii** Zahlbr.
25. Medulla KC+ rose or red.
26. KC+ unknown present; Africa.
17. P. immaculata Kurokawa
26. Alectoronic acid present; tropical America.
27. Lobes linear-elongate, subdivaricate.
8. P. densirhizinata Kurokawa
27. Lobes sublinear, loosely adnate to subimbricate.
13. P. exsplendens Hale

III. THALLUS LACKING ISIDIA, SOREDIA, AND PUSTULES

1. Thallus yellowish green (usnic acid).
2. Thallus saxicolous . . . . . **P. flavida** Zahlbr.
2. Thallus corticolous.
3. Medulla K−, P+ orange red . . . . . **P. flavida** Zahlbr.
3. Medulla K+ red, P+ orange red.
4. Salacinic acid present . . . . . **4. P. citrella** Kurokawa
4. Norstictic acid present.
5. Thallus closely adnate; lobes sublinear; rhizines densely branched.
P. reducens Nyl.
5. Thallus loosely adnate to subdivaricate; lobes linear-elongate; rhizines moderately branched.
6. Lobes 1–2 mm. wide, sparsely rhizinate, subimbricate.
P. enderythraea Zahlbr.
6. Lobes 2–4 mm. wide, densely rhizinate, subdivaricate.
P. caraccensis Tayl.
1. Thallus mineral gray (usnic acid lacking).
7. Medulla pale yellow or in part ochraceous.
8. Pigment K−.
9. Apothecia stalked; rhizines richly branched . . **P. peruviana** Nyl.
9. Apothecia adnate; rhizines sparsely to moderately branched.
25. P. rigidula Kurokawa
8. Pigment K+ purple to purple black.
10. Thallus orange fluorescent under UV light (lichexanthone present).
11. Upper cortex maculate; thallus corticolous . . **P. silvatica** Lynge
11. Upper cortex not maculate; thallus saxicolous.
12. Medulla C+ red (olivetoric acid) . . . **P. osteoleuca** Nyl.
12. Medulla C−, P+ red (unknown).
11. P. erythrodes (Zahlbr.) Hale & Kurokawa
10. Thallus not fluorescent (lichexanthone absent).
13. Medulla P+ red (protocetraric acid) . . . . **P. bahiana** Nyl.
13. Medulla P− (fatty acids) . . . . . **P. lythgoeana** Dodge
7. Medulla white, no pigments present.
14. Medulla P+ yellow to orange red.
15. Medulla K+ yellow turning red.
16. Norstictic acid present . . . . . **3. P. canescens** Kurokawa
16. Salacinic acid present.

17. Thallus corticolous; rhizines densely branched.
P. sublaevigata (Nyl.) Nyl.
17. Thallus saxicolous; rhizines moderately branched
P. subsaxatilis B. de Lesd.
15. Medulla K− or K+ faint brownish.
18. Thallus saxicolous.
19. Cortex orange fluorescent in UV light (lichexanthone present).
P. brasiliana Nyl.
19. Cortex not fluorescent (lichexanthone absent).
P. osseoalbida Lynge
18. Thallus corticolous.
20. Medulla KC+ orange (barbatic acid present).
26. P. scytodes Kurokawa
20. Medulla KC+ rose (protocetraric acid present).
21. Spores 15–25 μ long.
22. Spores 20–25 μ long; fatty acid present . **P. keitauensis** Asah.
22. Spores 15–20 μ long; fatty acids lacking.
P. manilensis Vain.
21. Spores 8–12 μ long.
23. Apothecia large, the disc split radially; Africa.
14. P. fissicarpa Kurokawa
23. Apothecia small, the disc entire; tropical America.
24. Rhizines moderately branched lobes subrotund often, whitish pruinose . . . . . **P. insinuans** Nyl.
24 Rhizines fine, densley branched; lobes sublinear, epruinose.
P. bahiana Nyl.
14. Medulla P−.
25. Medulla C−, KC+ orange (barbatic acid).
26. Thallus subdivaricate, the lobes linear-elongate; rhizines mostly moniliform . . . . . **22. P. monilifera** Kurokawa
26. Thallus adnate, the lobes sublinear; rhizines normal, not moniliform.
27. Upper cortex distinctly maculate . . . . . **P. boliviana** Nyl.
27. Upper cortex not distinctly maculate.
28. Amphithecium strongly rugose; Java.
P. bostrychodes Zahlbr.
28. Amphithecium smooth; tropical America.
29. Lobes sublinear to linear-elongate; rhizines densely branched.
P. physcioides Nyl.
29. Lobes shorter, subimbricate; rhizines sparsely to moderately branched . . . . . **P. zahlbruckneri** Lynge
25. Medulla C+ rose or red or C−, KC+ red.
30. Medulla C+ rose (gyrophoric acid).
31. Lobes linear-elongate, subdivaricate.
12. P. exporrecta Kurokawa
31. Lobes sublinear, adnate.
32. Lobes plane to more or less canaliculate, pale brown in a rather wide zone at the margins below; spores 14–21 μ long.
P. pluriformis Nyl.
32. Lobes plane, pale brown only in a very narrow zone below; spores to 12 μ long.
33. Thallus large, 4–8 cm. broad, the lobes 2–4 mm. wide.
27. P. scytophylla Kurokawa

33. Thallus smaller, 2–5 cm. broad, the lobes 1–2 mm. wide.
P. revolutella Nyl.

30. Medulla C+ red or C− (gyrophoric acid lacking).
34. Medulla C+ red to orange red (olivetoric acid).
P. intercalanda Vain.

34. Medulla C−.
35. Medulla KC+ red (alectoronic acid).
36. Thallus adnate, the lobes sublinear . . . . **7. P. degelii** Hale
36. Thallus loosely attached, subdivaricate.
37. Lobes narrow, 1–2 mm. wide.
20. P. lineariloba Kurokawa
37. Lobes wider, 2–4 mm. wide.
38. Rhizines densely branched, about 1 mm. long; tropical America . . . . . **16. P. gigas** Kurokawa
38. Rhizines moderately branched, 2 mm. or more long; Hawaii . . . . . **P. cervicornis** Tuck.
35. Medulla KC+ rose (alectoronic acid absent).
39. Upper cortex distinctly maculate . . . . . **P. pulvinata** Fée
39. Upper cortex not distinctly maculate.
40. Upper cortex flaking away, fragile; evernic acid present.
P. taylorensis Mitch.
40. Upper cortex continuous, not flaking; KC+ unknown substances present.
41. Spores uniseriate, 6–8 μ long; North America.
P. livida Tayl.
41. Spores biseriate, 14–18 μ long; South America.
42. Thallus corticolous; apothecial disc flesh-colored.
P. damaziana Zahlbr.
42. Thallus saxicolous; disc dark brown.
P. gracilescens Vain.

1. Parmelia anaptychioides Kurokawa, sp. nov. PLATE 5

Thallus adnatus, cinereo-albicans, 2–5 cm. diametro, lobis sublinearibus, separatis, 0.5–2.0 mm. latis, superne plus minusve convexus, sorediatus, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia ignota.

Thallus adnate on bark, pale olive gray to gray (R), 2–5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, separate at the circumference, 0.5–2.0 mm. wide, 160–220 μ thick, the margins smooth, narrowly black-rimmed; upper surface more or less convex, shiny on younger lobes, dull and irregularly cracked on older lobes, sorediate, the soredia mainly laminal, 1–2 mm. in diameter, often fusing; medulla white; undersurface black, dark brown in a narrow zone at the tips, the rhizines black, branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ faint red, P+ orange red, atranorine and protocetraric acid present.

Type in Michigan State University, collected on low ridge connecting La Rucilla and Pico Trujillo, Maciso Central, Cordillera Central,

elev. 8000 ft., Dominican Republic, August 8, 1958, by C. Wetmore (no. 3617; isotype in US).

This species is related to *P. pseudosinuosa* Asah. but the soralia are mainly laminal. The lobes are sublinear to linear-elongate and narrower than in *P. pseudosinuosa*. It is also close to *P. subaffinis* Zahlbr., especially in size and position of soralia, but it is differentiated by the absence of lichexanthone. *Parmelia anaptychioides* is known only from the West Indies, where it occurs on pine trees at higher elevations.

Additional specimens examined: Jamaica: Blue Mountain Peak, 7000 ft., *Imshaug* 15533 (MSC). Haiti: South of Forêt des Pins, 5500 ft., Dept. l'Ouest, *Imshaug* 22779 (MSC).

2. Parmelia brevirhiza Kurokawa, sp. nov. PLATE 3

Thallus adnatus, ca. 5 cm. diametro, olivaceo-cinerascens, lobis subirregularibus, 1–4 mm. latis, subrotundatis, margine crenatis, superne opacus vel nitidulus, submaculatus, partim leviter albo-pruinosus, sorediatus, sorediis capitatis, subtus niger, dense brevi-rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia rara, adnata, usque ad 5 mm. diametro; hymenium 50–55 μ altum; sporae male evolutae, 3–4×6–8 μ.

Thallus adnate on bark, cream buff (R), about 5 cm. in diameter; lobes subirregular to sublinear, more or less subrotund and sub-imbricate, 1–4 mm. wide, 140–170 μ thick, the margins subcrenate; upper surface plane to rugulose, shiny and more or less white-maculate to dull and lightly white-pruinose, sorediate, the soredia mostly subterminal, strongly capitate, diffuse, medulla white; undersurface black, densely short rhizinate, dark brown and papillate in a very narrow zone at the tips, the rhizines black, finely branched, about 0.1 mm. long, projecting as a narrow mat beyond the margins. Apothecia very rare, adnate, to 5 mm. in diameter, amphithecium sorediate, disc plane; hymenium 50–55 μ high; spores poorly developed, 3–4× 6–8 μ.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC− P+ pale orange red, atranorine and salacinic acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected in *Nothofagus* rain forest, Isla Riesco, Mina Elena, Terr. Magallanes, Chile, Apr. 29, 1940, by R. Santesson (no. 2066; isotype in US).

Parmelia brevirhiza has a distinct whitish cast, caused by faint pruinosity, and large subterminal and projecting soralia 2–4 mm. in diameter. The sorediate lobes are strongly revolute or contorted. This species resembles *P. majoris* Vain., which is known from Asia and Madagascar, in the presence of soredia and salacinic acid. *Parmelia brevirhiza* has more densely branched rhizines, which form a mat on the undersurface. *Parmelia majoris* contains zeorine in

addition to salacinic acid. *Parmelia brevirhiza* is very common in southern Argentina and Chile and there is one quite unexpected record from Java.

Additional specimens examined: Argentina: Lago Roca, *Santesson* 1085 (S); Río Piper, Ushuaia, Tierra del Fuego, *Santesson* 417 (S); Lago Verde, near Futalaufquen, Prov. Chubut, *Lamb* 5864 (CAN, US). Chile: Punta Guapacho, Peninsula Lacui, Isla Chiloé, Prov. Chiloé, *Santesson* 4135 (S); Cerros Divisaderos, Coyhaique, Terr. Aysén, *Santesson* 4456 (S); Mina Elena, Isla Riesco, *Santesson* 7849 (S); Estancia Maria, Seno Skyring, Terr. Magallanes, *Santesson* 1974, 1997 (S); Puerto Yartou, Canal Whiteside, *Santesson* 5791, 6759 (S); Río Condor, south of Puerto Yartou, Canal Whiteside, *Santesson* 5905 (S); Puerto Navarino, Isla Navarino, *Santesson* 7404 (S, US); Porvenir, Tierra del Fuego, *Santesson* 5372 (S). Java: Near Madang-Aer Batumbuk, *Groenhart* 9268 (BO).

3. Parmelia canescens Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans, 3–7 cm. latus, lobis irregularibus, subrotundatis, 1–5 mm. latis, margine subcrenatis, superne opacus, parte albo-pruinosus, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis nigris, sparse vel modice ramosis, Apothecia adnata, 1.5–4.5 mm. diametro; hymenium 40–50 μ altum; sporae 5–6×8–10 μ.

Thallus adnate on twigs, pale olive buff (R), 3–7 cm. in diameter; lobes irregularly branched, subrotund apically, 1–5 mm. wide, the margins more or less crenate, rarely lobulate; upper surface plane, dull, sometimes faintly white-pruinose, not maculate, irregularly rugose or cracked on older lobes, isidia and soredia lacking; medulla white; undersurface uniformly black, sparsely to moderately branched; rhizines black, moderately branched, about 0.5 mm. long. Apothecia adnate, amphithecium rugulose, pruinose, disc vandyke brown (R); hymenium 40–50 μ high; spores 5–6×8–10 μ.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red C—, KC—, P+ pale orange, atranorine and norstictic acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected at Hacienda de Cayquenes, Colchagua, Chile, Aug. 22, 1896, by P. Dusén (no. 92; isotype in US).

Parmelia canescens externally resembles *P. sublaevigata* (Nyl.) Nyl. in having a similar adnate thallus and irregularly branched lobes. *Parmelia canescens* contains norstictic acid, whereas *P. sublaevigata* contains salacinic acid. Moreover, the rhizines of *P. canescens* are sparsely to moderately branched while those of *P. sublaevigata* are more densely and finely branched. It is hoped that further collections of these rare species will further clarify their relationships.

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4. Parmelia citrella Kurokawa, sp. nov.

Thallus adnatus, corticola, viridiflavicans, 3–8 cm. latus, lobis sublinearibus, subimbricatis, 1.0–2.5 mm. latis, superne nitidulus, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis nigris, furcatis. Apothecia adnata, 2–10 mm. diametro; hymenium 25–35 μ altum; sporae 7–9×12–14 μ.

Thallus adnate on bark, sea-foam yellow (R), 3–8 cm. in diameter; lobes dichotomously branched, sublinear to linear-elongate, more or less imbricate, 1.0–2.5 mm. wide, 90–140 μ thick, the margins smooth, often narrowly black-rimmed; uppersurface plane to convex, rather shiny, isidia and soredia lacking, pycnidia forming blackish papillae on older lobes; medulla white; undersurface black, rhizinate, the rhizines black, rather long, moderately branched, often projecting beyond the margins. Apothecia adnate, 2–10 mm. in diameter, exciple crenate to undulate, disc Hay's brown to light seal brown (R), radially split, amphithecium smooth to rugose; hymenium 25–35 μ high; spores 7–9×12–14 μ.

Reactions: Thallus K+ yellowish; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, usnic acid and salacinic acid present.

Type in the Herbarium Bogoriense, collected at G. Gedeh, Java, elev. 2900 m., March 7, 1938, by H. van Woerden (isotype in US).

Parmelia citrella is very close to *P. reducens* Nyl., but the thallus is more loosely attached and the rhizines are consistently longer. *Parmelia reducens* also differs chemically in producing norstictic acid, and on the basis of a few measurements the spores seem to be slightly smaller (9–11 μ long). *Parmelia citrella* appears primarily to be an Indonesian species, while *P. reducens* is known only from South America.

Additional specimens examined: Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 5–12, 1948 (MO, US). Colombia: Sierra de Santa Maria, elev. 8000 ft., *Humbry-Troy* 313 (K). Java: G. Gedeh, *van Woerden* 2023 (BO); G. Pangerango, *Reijnvaan* 150 (BO); no locality, *Horsfield* (BM).

5. Parmelia crenata Kurokawa, sp. nov.

Thallus laxe adnatus, muscicola, albido-cinerascens, 3–6 cm. diametro, lobis subirregularibus, subimbricatis, apice subrotundatis vel subtruncatis, 1.5–5.0 mm. latis, margine crenatis, superne laevigatus, emaculatus, isidiatus, subtus niger, ambitu castaneus, sparse rhizinosus, rhizinis nigris, modice furcatis. Apothecia ignota.

Thallus loosely attached, growing over mosses on rocks, yellowish glaucous to light mineral gray (R), 3–6 cm. in diameter; lobes irregularly branched, more or less imbricate, rounded at the tips,

1.5–5.0 mm. wide, 90–110 μ thick, the margins crenate; upper surface smooth, without maculae, moderately isidiate, the isidia short, less than 0.5 mm. high, often branched; medulla white; undersurface black, pale brown in a narrow zone at the tips, sparsely rhizinate, the rhizines black, sparsely to moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C—, KC—, P+ pale orange, atranorine and stictic acid present.

Type in the National Science Museum, Tokyo, collected on Mount Kuishi, Tosa-gun, Tosa-ken, Shikoku, Japan, Dec. 14, 1960, by S. Kurokawa (no. 60154; isotype in US).

Parmelia crenata might at first be mistaken for *P. koyaensis* Asah., but the lobes are consistently smaller and more or less sublinear. It is the only species in section *Hypotrachyna* that contains stictic acid. *Parmelia koyaensis* contains protocetraric acid. Thus far *P. crenata* is known only from the type locality in Japan.

6. Parmelia croceopustulata Kurokawa, sp. nov. PLATE 9

Thallus adnatus, albido-cinerascens, ca. 5 cm. diametro, lobis sublinearibus, 1.5–3.5 mm. latis, margine integris, superne nitidus, emaculatus, aetate rugulosus, pustulato-sorediatus, soraliis partim subcoloratis, subtus niger, rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1–6 mm. diametro; hymenium 50–60 μ altum; sporae non visae.

Thallus adnate on bark, yellowish glaucous (R), 4–9 cm. in diameter; lobes dichotomously branched, sublinear, 1.5–3.5 mm. wide, 150–220 μ thick, the margins entire to more or less dissected; upper surface shiny, rugulose with age, without maculae, sorediate, the soralia capitate and subterminal, 1–5 mm. in diameter, originating from pustules; medulla below the soralia yellow ochre (R), otherwise white; undersurface black, rhizinate, the rhizines black, shiny, branched. Apothecia rare, adnate, 1–6 mm. in diameter, exciple sorediate, disc chestnut brown (R), radially split; hymenium 50–60 μ high; mature spores not seen.

Reactions: Thallus K+ yellow; medulla K—, C—, KC— or KC+ reddish, P+ orange red or in part P—, soralia P+ orange red, pigment under the soralia K+ purple, atranorine, protocetraric acid, and rhodophyscin present.

Type in Michigan State University, collected on fir around summit of Grandfather Mountain, Avery Co., North Carolina, elev. 5964 ft., June 23, 1958, by H. Imshaug (no. 22275; isotype in US).

Parmelia croceopustulata is related to species in the *P. livida* group, especially *P. formosana* Zahlbr. and *P. leiophylla* Kurokawa, both fo which also produce rhodophyscin. *Parmelia formosana* differs in having nonsorediate pustules and lichexanthone. *Parmelia leiophylla*

has similar sorediate pustules but produces olivetoric acid. This species seems to be restricted to higher elevations in Hispaniola and Jamaica, with several interesting disjunct localities in the Appalachian Mountains.

Additional specimens examined: United States: Virginia: White Top Mountain, Washington Co., elev. 5200 ft., *Hale* 18662 (US); North Carolina: Roan Mountain, Avery Co., elev. 6200 ft., *Hale* 18071 (US); Mt. Mitchell, Yancey Co., elev. 6684 ft., *Imshaug* 22383, 22390 (MSC, US); Newfound Gap, Swain Co., *Imshaug* 22435 (MSC, US); Mt. Pisgah, Haywood Co., *Green* in 1959 (US). Dominican Republic: Trail to Alto de la Bandera, Cordillera Central, La Vega, *Imshaug* 23470 (MSC, US). Haiti: Pic La Selle, Morne La Selle, elev. 8844 ft., *Wetmore* 3120 pr. p. (MSC); above Le Refuge, Montagne Noire, Kenscoff, *Imshaug* 22538 (MSC). Jamaica: Mossmans Peak, *Imshaug* 14726 (MSC); High Peak, Blue Mountains, elev. 6800 ft., *Imshaug* 15254 (MSC).

7. Parmelia degelii Hale, sp. nov. PLATE 5

Thallus arcte adnatus, corticola, cinereo-albicans, 4–8 cm. diametro, lobis sublinearibus, 1–2 mm. latis, contiguis, superne rugulosus, isidiis sorediisque destitutus, subtus modice rhizinosus, rhizinis sparse vel modice dichotome ramosis. Apothecia adnata, 3–5 mm. diametro; hymenium 50–60 μ altum; sporae 4–5$\times$8–11 μ.

Thallus closely adnate on bark, 4–8 cm. in diameter, mineral gray; lobes sublinear, 1–2 mm. wide, 140–170 μ thick, contiguous, the margins entire; upper surface dull to more or less shiny, rugulose, transversely rugose with age, isidia and soredia lacking; medulla white; undersurface black, moderately rhizinate, the rhizines sparsely to moderately branched, dichotomous. Apothecia adnate, 3–5 mm. in diameter, the exciple crenate, disc plane; hymenium 50–60 μ high; spores 4–5$\times$8–11 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, alectoronic acid, and α-collatolic acid present.

Type in the herbarium of G. Degelius, collected between Luso and Cachipoque, Moxico, Angola, about 1300 m. elevation, Feb. 16, 1960, by G. Degelius (isotype in US).

Parmelia degelii is very close to *P. livida* Tayl. in general habit and color, but *P. livida*, a temperate American lichen with several localities in South Africa, has smaller spores (4–5$\times$6–8 μ), somewhat denser and more richly branched rhizines, and a different chemistry (KC+ red unknown). *Parmelia degelii* is unusual in being the second known species of section *Hypotrachyna* with alectoronic acid in Africa. The other species is *P. exsplendens* Hale, which also occurs in the Caribbean area. The five remaining species in section *Hypotrachyna* with alectoronic acid occur exclusively in tropical America (*P. densirhizinata*

Kurokawa, *P. ensifolia* Kurokawa, *P. gigas* Kurokawa, and *P. lineariloba* Kurokawa) or in Hawaii (*P. cervicornis* Tuck.).

Additional specimens examined: Angola: Same locality and data as the holotype (DEGEL); Rio Kuiriri, near Kassuango, Bie, *Gossweiler* 3256d (BM).

8. Parmelia densirhizinata Kurokawa, sp. nov. PLATE 8

Thallus laxe adnatus, corticola, albido-cinerascens, 6–13 cm. latus, lobis lineari-elongatis, subdivaricatis, 2–6 mm. latis, margine integris, superne planus, emaculatus, pustulato-sorediatus, soraliis subterminalibus, subtus niger, rhizinosus, rhizinis densis, dichotome ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale glaucous green (R), 6–13 mm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, 2–6 mm. wide, 110–150 μ thick, the margins smooth, narrowly black-rimmed; upper surface plane, continuous, without maculae, sorediate, the soralia mainly subterminal, 1–3 mm. in diameter, originating from pustules; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, dichotomously branched, 1–2 mm. long, projecting in a mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Type in the U.S. National Herbarium, collected on the east side of Volcán Chiriquí, Prov. Chiriquí, Panama, elev. 1500–3000 ft., Dec. 5–12, 1948, by P. F. Scholander.

Parmelia densirhizinata is a typical subdivaricate species related to *P. gigas* Kurokawa, a tropical American species, and *P. cervicornis* Tuck., a Hawaiian species. They all produce alectoronic acid, but *P. densirhizinata* is easily distinguished by the subterminal sorediate pustules. It is widespread in tropical America, occurring in mountains between 2000 and 3750 m. elevation.

Additional specimens examined: Guatemala: Pacajá, region of Desconsuelo, Totonicapán, *Standley* 84522 (MO). Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 11, 1948 (US). Haiti: Ridge east of Pic La Selle, Morne La Selle, elev. 8300 ft., *Imshaug* 23026 (MSC). Dominican Republic: Trail to Alto de la Bandera Cordillera Central, La Vega, elev. 7200 ft., *Imshaug* 23486 (MSC). Colombia: Páramo de Guasca, Dept. Cundinamarca, *Killip* 34118 (US); Chorreón San Paulina, Nevada del Cocuy, Dept. Boyacá, elev. 3750 m., *Cuatrecasas* 1348a (US). Ecuador: Mount Tunguragua, *Spruce* 175 (K). Peru: Pampalca, Dept. Ayacucho, elev. 3200 m., *Killip & Smith* 22237 (US). Bolivia: Unduavi Valley, *Julio* 413 (US). Chile: Isla de Chiloe, *Joseph* 2245 (US); Cerro Tralcan, Lago Rinihue,

Prov. Valdivia, *Santesson* 3451 (S); Canal Whiteside, Puerto Yartou, Tierra del Fuego, *Santesson* 6799 (S).

9. Parmelia dentella Hale & Kurokawa, sp. nov. PLATE 5

Thallus laxe adnatus, saxicola, viridi-cinerascens, 3–8 cm. diametro, lobis sublinearibus vel subirregularibus, subimbricatis, 2–6 mm. latis, margine dentato-crenatis, superne planus, albomaculatus, dense isidiatus, subtus nigricans, sparse vel modice rhizinosus, rhizinis nigris, ramosis. Apothecia ignota.

Thallus loosely adnate on shaded rocks, yellowish glaucous to glaucous green (R), 3–8 cm. in diameter; lobes irregularly branched, sublinear to subirregular, more or less imbricate, 2–6 mm. wide, 150–230 μ thick, the margins in part dentate-crenate; upper surface plane, distinctly white-maculate, densely isidiate, the isidia often branched, cylindrical, less than 0.7 mm. high; medulla white; under-surface black, pale brown in a rather broad zone at the tips, sparsely to moderately rhizinate, the rhizines black, shiny, moderately branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellowish, C—, KC—, P+ pale orange red, atranorine and an unknown P+ substance present.

Type in the U.S. National Herbarium, collected on granite at Cheaha State Park, Clay County, Alabama, Mar. 16, 1962, by H. McCullough (no. 570; isotypes in TNS and the herbarium of Howard College, Birmingham, Alabama).

Parmelia dentella bears a striking resemblance to the endemic Japanese species *P. crenata* Kurokawa. It differs from *P. crenata* in having the upper cortex distinctly white-maculate and in producing a P+ unknown substance instead of stictic acid. It also resembles *P. costaricensis* Nyl., especially in the maculae, isidia, and size of the thallus, but the rhizines of *P. costaricensis* are much more densely branched and its main component is caperatic acid (P—). *Parmelia dentella* is still known only from the type locality in Alabama, a rather dry oak forest rich in many kinds of lichens. It will probably be found again in the foothills of the Appalachian Mountains.

10. Parmelia ensifolia Kurokawa, sp. nov. PLATE 7

Thallus adnatus, albido-cinerascens, 5–11 cm. latus, lobis sublinearibus, 1–4 mm. latis, margine lobulatis, superne nitidus, emaculatus, isidiato-lobulatus, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia adnata, 3–4 mm. diametro; hymenium 50–65 μ altum; sporae 8–10$\times$14–18 μ.

Thallus loosely adnate, corticolous, pearl gray (R), 5–11 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1–4 mm. wide, 160–200 μ thick, the margins with numerous lobules, the lobules

ascending, dorsiventral, short-rhizinate below, often branched, up to 1.5 mm. long; upper surface shiny, without maculae, short-isidiate-lobulate to lobulate on the margins; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, dichotomously branched. Apothecia adnate, 3–4 mm. in diameter, disc tawny olive (R), amphithecium rugose; hymenium 50–65 μ high; spores 8–10×14–18 μ.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ rose or red, P—, atranorine and alectoronic acid present.

Type in Michigan State University, collected in pine forest below summit of Alto de la Bandera, Cordillera Central, La Vega, Dominican Republic, elev. 8300 ft., Aug. 5, 1958, by H. Imshaug (no. 23430; isotype in US).

Parmelia ensifolia has sublinear lobes and laminal and marginal lobules similar to those of *P. culmigena* Zahlbr. and *P. digitata* Lynge. The latter two species, however, are distinctly maculate and differ chemically, *P. culmigena* having evernic acid and *P. digitata* having barbatic acid. *Parmelia ensifolia* is distinguished by the presence of alectoronic acid and lack of maculae. It seems to be rather common in tropical America.

Additional specimens examined: Mexico: No data on locality, 1890 (S). Panama: Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 5–12, 1948 (MO, US). Jamaica: Summit of Blue Mountain Peak, *Maxon* 9865 (US). Haiti: Pic La Selle, Morne La Selle, *Wetmore* 3086 (MSC, US). Dominican Republic: Below summit of Alto de la Bandera, Cordillera Central, La Vega, elev. 8300 ft., *Wetmore* 3511 (MSC, US). Venezuela: Pan de Azúcar, Mérida, *Jahn* 241 (US); Laguna de Canoa, Sierra de Santo Domingo, Mérida, *Dennis* 1924, 1950 (K).

11. Parmelia erythrodes (Zahlbr.) Hale & Kurokawa, comb. nov.

Parmelia brasiliana Nyl. var. *erythrodes* Zahlbr. Denkschr. Akad. Wiss. Wien Math. Naturw. 83: 169. 1927. Type collection: Mt. Itatiaya, Minas Gerais, Brazil, *Schiffner*, September 1901 (WU, holotype).

Thallus adnate on rock, ivory yellow, deep mouse gray towards the center, about 5 cm. in diameter; lobes dichotomously branched, sublinear-elongate, 1–2 mm. wide, 140–190 μ thick, the margins entire to subcrenate; upper surface plane, shiny, emaculate, tangentially cracked on older lobes, isidia and soredia lacking; medulla pale pinkish buff in the lower half, white above; undersurface uniformly black, moderately rhizinate, the rhizines black, moderately branched, 0.5–1.0 mm. long. Apothecia adnate, 2–6 mm. in diameter, exciple undulate, disc imperforate, blackish brown; hymenium 50–60 μ high; spores 5–6×9–10 μ, episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ rose, P—, pigment K+ reddish purple, atranorine, a KC+ unknown (apparently the same as the one in *P. livida* Tayl.), rhodophyscin, and lichexanthone.

Parmelia erythrodes is very close to *P. brasiliana* Nyl., differing chiefly in chemistry. *Parmelia brasiliana* lacks rhodophyscin and the KC+ substance but contains lichexanthone and in addition protocetraric acid. Both species are typically saxicolous and occur rather rarely in South America.

Additional specimen examined: Peru: Without locality, *Lobb* s.n. (BM).

12. Parmelia exporrecta Kurokawa, sp. nov. PLATE 6

Thallus laxe adnatus, albido-cinerascens, 7–10 cm. latus, lobis lineari-elongatis, subdivaricatis, 2–6 mm. latis, superne planus, nitidus, emaculatus, sorediis isidiisque destitutus, subtus niger, rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale glaucous green (R), 7–10 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, 2–6 mm. wide, 150–220 μ thick, the margins smooth, rarely lobulate; upper surface plane and smooth, shiny, often pruinose near the tips, without maculae, isidia or soredia; medulla white; undersurface black, rhizinate, the rhizines black, shiny, densely branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ rose, KC+ red, P—, atranorine and gyrophoric acid present.

Type in the United States National Herbarium, collected in mature pine-oak forest, on trail leading to Cerro San Felipe, Oaxaca, Mexico, elev. about 3000 m., Apr. 1, 1960, by M. E. Hale (no. 20722).

Parmelia exporrecta seems to be the nonsorediate ally of *P. thysanota* Kurokawa (see below). It has a large subdivaricate thallus and linear-elongate lobes, much as in *P. gigas* Kurokawa, which differs in containing alectoronic acid.

Additional specimen examined: Mexico: Vera Cruz: Orizaba, *Liebmann* 116 (UPS).

13. Parmelia exsplendens Hale, sp. nov.

Thallus adnatus, viridi- vel cinereo-albicans, 4–8 cm. diametro, lobis sublinearibus, 1.5–2.5 mm. latis, superne nitidus, valde albomaculatus, sorediatus, soralis subterminalibus, subtus niger, dense rhizinosus, rhizinis dichotome ramosis. Apothecia ignota.

Thallus adnate, greenish to whitish gray, 4–8 cm. across, corticolous; lobes sublinear, dichotomously branched, 1.5–2.5 mm. wide, 160–200 μ thick, the margins entire to subcrenate; upper surface plane, shiny, strongly white-maculate, sorediate, soralia capitate,

subterminal; medulla white; undersurface black, densely rhizinate, the rhizines black, dichotomously branched. Apothecia unknown.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Type in Michigan State University, collected on ridge northwest of Murdock's Gap, Blue Mountains, Jamaica, elev. 3600 ft., Mar. 19, 1953, by H. Imshaug (no. 15306; isotype in US).

This species resembles *P. metarevoluta* Asah. from Asia in having a medium-sized thallus and subterminal capitate soralia. However, it is distinctly white-maculate and the rhizines are densely branched. *Parmelia exsplendens* is fairly common in the Caribbean with one disjunct record from South Africa.

Additional specimens examined: Mexico: Virgin upland jungle, El Suspiro, Chiapas, *Hale* 20229 (US). Guatemala: Near Tactic, Alta Verapaz, *Standley* s.n. (MO, no. 185561). Jamaica: Gap south-east of Catherine's Peak, *Imshaug* 13894 (MSC); gap on northeast spur of High Peak, *Imshaug* 15287 (MSC); Woodcutters Gap, *Imshaug* 13423 (MSC, US); Summit, Blue Mountains, *Imshaug* 13855 (MSC); west slope of John Crow Mountains, above Corn Puss Gap, *Imshaug* 14577 (MSC). Union of South Africa: 5 mi. east of Mokobulaan, Lydenberg, Transvaal, *Almborn* 7496 (LD).

14. Parmelia fissicarpa Kurokawa, sp. nov. PLATE 7

Thallus adnatus vel laxe adnatus, albido-cinerascens, ca. 14 cm. diametro, lobis sublinearibus vel subirregularibus, 2–4 mm. latis, margine subcrenatis superne nitidulus, emaculatus, isidiis sorediisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia substipitata, ca. 10 mm. diametro; hymenium 60–70 μ altum; sporae 6–7×8–10 μ.

Thallus adnate to loosely attached on rock, pale olive buff (R), about 14 cm. in diameter; lobes irregularly branched, sublinear to subirregular, 2–4 mm. wide, 210–250 μ thick, the margins subcrenate; upper surface rather shiny, without maculae, the older lobes rugulose, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, moderately branched, often more than 1.5 mm. long. Apothecia substipitate, 10 mm. or more in diameter, exciple undulate, amphithecium rugose, disc carob brown (R), radially split; hymenium 60–70 μ high; spores 6–7×8–10 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ faint red, P+ orange red, atranorine and protocetraric acid present.

Type in the Botanical Museum, Lund University, collected 2 miles south of forester's office, Cathedral Peak Area, Bergville, Natal, Union of South Africa, Nov. 7, 1953, by Ove Almborn (no. 9374; isotype in US).

This peculiar species has an exceptionally large thallus and apothecia. It resembles *P. insinuans* Nyl., a tropical American species, and *P. keitauensis* Asah. and *P. manilensis* Vain., both Asian species, in having rather irregularly branched lobes and protocetraric acid. Although *P. fissicarpa* and *P. insinuans* have similar spore size, the thallus of *P. fissicarpa* is much larger and the rhizines are longer. In addition, *P. insinuans* often produces the pigment rhodophyscin along with protocetraric acid. *Parmelia fissicarpa* is clearly distinguished from *P. keitauensis* by the absence of fatty acids and by smaller spores. *Parmelia manilensis* differs in having adnate and quite small apothecia (1–3 mm. in diameter) and large spores.

15. Parmelia flavovirens Kurokawa, sp. nov. PLATE 8

Thallus adnatus, corticola, viridiflavicans, 3–6 cm. diametro, lobis sublinearibus, 1.0–2.5 mm. latis, margine subcrenatis, superne nitidus, aetate rugulosus, centrum versus lobulatus, sorediatus, soraliis subterminalibus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 2–4 mm. diametro; hymenium 60–75 μ altum; sporae 7–10×11–15 μ.

Thallus adnate on bark, sea-foam green (R), 3–6 cm. in diameter; lobes more or less irregularly branched, sublinear, 1.0–2.5 mm. wide, 130–150 μ thick, the margins more or less crenate, often narrowly black-rimmed; upper surface shiny near the tips, more or less rugulose and irregularly cracked on older lobes, sometimes lobulate toward the center, sorediate, soralia mainly subterminal; medulla white; undersurface black, densely rhizinate, the rhizines black, branched. Apothecia adnate, 2–4 mm. in diameter, exciple crenate, amphithecium rugose, disc light seal brown (R); hymenium 60–75 μ high; spores 7–10×11–15 μ.

Reactions: Thallus K+ yellowish; medulla K−, C−, KC+ faint red, P+ deep orange red, usnic acid, and protocetraric acid present.

Type in the Naturhistoriska Riksmuseet, Stockholm, collected near Hotel Rio Rubens, 50 km. southeast of Natales, Magallanes, Chile, Jan. 14, 1941, by R. Santesson (no. 5681; isotype in US).

Parmelia flavovirens is very close in external appearance to *P. sinuosa* (Sm.) Ach. and *P. velloziae* Vain. The last named species has similar chemistry but contains in addition the orange-red pigment rhodophyscin under the soralia. *Parmelia sinuosa* produces salacinic acid. *Parmelia flavovirens* is apparently endemic to southernmost Chile where it occurs intermingled with *P. sinuosa*.

Additional specimens examined: Chile: Puerto Navarino, Isla Navarino, Tierra del Fuego, *Santesson* 1261 (S); Aysén: Coyhaígue, *Santesson* 8406 (S).

16. Parmelia gigas Kurokawa, sp. nov. PLATE 8

Thallus laxe adnatus, corticola, albido-cinerascens, 15–40 cm. diametro, lobis lineari-elongatis, subdivaricatis, 3–10 mm. latis, margine integris, superne planus, emaculatus, isidiis sorediisque destitutus, subtus niger, breve rhizinosus, rhizinis nigris, dense ramosis. Apothecia usque ad 15 cm. diametro, substipitata; hymenium 50–65 μ altum; sporae 8–10×16–18 μ.

Thallus loosely attached on bark, mosses, or humus, turning from ivory yellow to cream buff (R) in the herbarium, 15–40 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate and separate, 3–10 mm. wide, 220–330 μ thick, the margins smooth, rarely short lobulate; upper surface plane and smooth, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, short rhizinate, partly naked, the rhizines black, shiny, densely branched, about 1 mm. long, forming a mat projecting narrowly beyond the margins. Apothecia rare, to 15 mm. in diameter, substipitate, amphithecium strongly rugose, faintly maculate; hymenium 50–65 μ high; spores 8–10×16–18 μ, the episporium 1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Type in the United States National Herbarium, collected at Laguna Verjou, above Bogotá, Colombia, 1922, by Ariste Joseph (no. B70; isotypes in DUKE, REN, S, TNS).

This species has a large divaricate thallus, long linear-elongate lobes, and densely branched, short rhizines. Externally it is very similar to and has been misidentified as *P. caraccensis* Tayl., which differs significantly in producing usnic and norstictic acids. It is also related to the Hawaiian species *P. cervicornis* Tuck. in that it produces the same chemical substances. The thallus of *P. gigas*, however, is much larger and the lobes ordinarily wider than in *P. cervicornis*. The rhizines of *P. gigas*, furthermore, are short, usually about 1 mm. long, and form a dense mat on the lower side, whereas the rhizines of *P. cervicornis* are often more than 2 mm. long and relatively sparse. *Parmelia gigas* is widely distributed in tropical America, being especially common at higher elevations (up to 3900 m.) in cloud forests.

Additional specimens examined: Mexico: Oaxaca: Trail leading to Cerro san Felipe, elev. 2920–3000 m., *Hale* 20707, 20723, 20783, 21100 (US). Panama: Craters edge, Volcán Chiriquí, Prov. Chiriquí, *Scholander*, Dec. 12, 1948 (MO). Venezuela: Pan de Azúcar, Cordillera de Mérida, elev. 4000 m., *Jahn* 240 (US). Colombia: Carrizales, north of Las Brisas, Cordillera Occidental, Dept. Valle, *Cuatrecasas* 20545 (US); eastern slope of Páramo de las Coloradas, Dept. Santander, elev. 3300–3900 m., *Killip & Smith* 18394, 18481 (US); Los Gaques,

western slope of Páramo de Guasca, Dept. Cundinamarca, elev. 3250 m., *Killip* 34064B (US); without locality: *Lindig* 2573 (UPS). Ecuador: Páramo de Minza Chica, Tunguragua, elev. 3800 m., *Penland* 404 (MO, US); Páramo de Volcán Cayambe, Dept. Pichincha, elev. 13,000 ft., *Prescott* (MSC, US).

17. Parmelia immaculata Kurokawa, sp. nov.

Thallus adnatus, corticola, albido-cinerascens, 4–9 cm. latus, lobis sublinearibus, contiguis, 1–3 mm. latis, superne nitidulus, aetate rugosulus, sorediatus, soraliis laminalibus, subtus sparse rhizinosus, rhizinis nigris, brevibus, dichotome ramosis. Apothecia rara, substipitata, 1.5–4.5 mm. diametro; hymenium 50–60 μ altum; sporae 5–7$\times$9–10 μ.

Thallus adnate on bark, yellowish glaucous (R), 4–9 cm. across; lobes dichotomously branched, sublinear-elongate, contiguous, 1–3 mm. wide, 110–200 μ thick, the margins smooth or sparsely lobulate with age; upper surface rather shiny, plane, becoming rugulose and irregularly cracked on older lobes, sorediate, the soralia orbicular, laminal, often fusing; medulla white; undersurface sparsely rhizinate, minutely rugulose, black, the rhizines black, short, dichotomously branched. Apothecia more or less stipitate, 1.5–4.5 mm. in diameter, exciple crenate, amphithecium sorediate, disc vandyke brown (R), radially split; hymenium 50–60 μ high; spores 5–7$\times$9–10 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ rose, P−, pigment if present K+ purple, atranorine, KC+ unknown, and rhodophyscin present.

Type in the Botanical Museum, Lund University, collected at Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal, Union of South Africa, Oct. 11, 1953, by Ove Almborn (no. 6551; isotype in US).

Parmelia immaculata belongs to that group of species near *P. dactylifera* Vain. and *P. livida* Tayl., all of which contain the same unknown KC+ substance. *Parmelia dactylifera* is pustulate-isidiate, whereas *P. livida* lacks pustules and soredia. *Parmelia immaculata* is apparently a very common corticolous lichen in South Africa, occurring frequently with *P. leiophylla* Kurokawa. A single specimen from Java also seems to belong to this species.

Additional specimens examined: Africa: South of Felixburg, Southern Rhodesia, *Höeg*, April 2, 1930 (TRH); Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, Transvaal, *Almborn* 6440, 6550 (LD), 6247 (LD, US); Polela Forest, Polela, Natal, *Almborn* 9511 (LD, US); Stormsrivier, Humansdorp, *Almborn* 4132 (LD); Grootvadersbosch, Swellendam, Cape Province, *Almborn* 2194, 2195, 2196 (LD); Grahamstown, Albany, Cape Province, *Höeg*, December 1929 (TRH). Java: Tjibodas, *Neervoort* 3140 (BO).

18. Parmelia infirma Kurokawa, sp. nov. PLATE 7

Thallus laxe adnatus, corticola, olivaceo-albicans, 3–8 cm. diametro, lobis sublinearibus, subimbricatis, 1.0–3.5 mm. latis, margine subcrenatis, superne nitidus, emaculatus, isidiatus, subtus niger, breviter rhizinosus, rhizinis nigris, ramosis. Apothecia adnata, 1.0–2.5 mm. diametro; hymenium 60–85 μ altum; sporae 9–13×15–19 μ .

Thallus loosely adnate on bark, yellowish glaucous (R), 3–8 cm. across; lobes irregularly branched, sublinear, sometimes imbricate, 1.0–3.5 mm. wide, 130–170 μ thick, the margins more or less crenate, sometimes blackrimmed; upper surface shiny, without maculae, isidiate, the isidia cylindrical, moderate, simple to coralloid branched; medulla white; undersurface black, short-rhizinate, the rhizines black, shiny, branched. Apothecia adnate, 1.0–2.5 mm. in diameter, exciple entire, amphithecium usually isidiate, disc seal brown (R); hymenium 60–85 μ high; spores 9–13×15–19 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine, caperatic and protolichesteric acids present.

Type in the National Science Museum, Tokyo, collected at Darjeeling, Kurseong, India, Apr. 12, 1960, by H. Hara et al. (isotype in US).

This new species resembles *P. koyaensis* Asah. in external appearance, spore size, and presence of fatty acids. The isidia of *P. infirma* are shorter and sometimes become more or less granular. *Parmelia koyaensis* is P+ red, containing protocetraric acid, which has not been demonstrated in *P. infirma*. The related isidiate species *P. nodakensis* Asah. is KC+ rose and *P. crenata* Kurokawa contains stictic acid (K+ yellow). *Parmelia infirma* also resembles the tropical American species *P. costaricensis* Nyl., which is distinctly maculate. *Parmelia infirma* is known only from the type locality.

19. Parmelia leiophylla Kurokawa, sp. nov. PLATE 9

Thallus adnatus, corticola, cinereo-albicans, 3–7 cm. diametro, lobis sublinearibus, contiguis, 1–3 mm. latis, superne planus, nitidulus, aetate rugosus, pustulatus, medulla pro parte ochracea, subtus niger, rhizinosus, rhizinis nigris, dichotome ramosis. Apothecia rara, adnata, usque ad 1 cm. diametro; hymenium 50–55 μ altum; sporae 5–6×10–13 μ.

Thallus adnate, corticolous, yellowish glaucous (R), 3–7 cm. across; lobes dichotomously branched, sublinear, contiguous, 1–3 mm. wide, 130–180 μ thick, the margins smooth; upper surface plane, rather shiny, rugulose on older lobes, pustulate, not distinctly sorediate, without maculae; medulla white, turning yellow ochre (R) under the pustules; undersurface black, rhizinate, the rhizines black, shiny, dichotomously branched, rarely projecting beyond the margins. Apothecia very

rare, adnate, to 1 cm. in diameter, amphithecium rugose, disc split with age, rarely abnormally perforate; hymenium 50–55 μ high; spores 5–6$\times$10–13 μ.

Reactions: Thallus K+ yellow; medulla K−, C+ deep red, KC+ red, P−, pigment K+ purple, atranorine, olivetoric acid, and rhodophyscin present.

Type in the Botanical Museum, Lund University, collected on Forest Drive from Houtbosch to Tzaneen, Pietersburg, Transvaal, Union of South Africa, Oct. 12, 1953, by Ove Almborn (no. 6796; isotype in US).

This species resembles *P. livida* Tayl. in general habitus but is separated by the sorediate pustules and chemistry. *Parmelia immaculata* Kurokawa, which has similar distribution in South Africa, is distinctly sorediate and C−, KC+ rose. *Parmelia formosana* Zahlbr. is strictly pustulate and contains lichexanthone. The American species *P. croceopustulata* Kurokawa has similar coarsely sorediate pustules and rhodophyscin, but the main component is protocetraric acid (C−, P+ red).

Additional specimens examined: Union of South Africa: Transvaal: Punch Bowl Inn, north of Louis Trichardt, Zoutpansberg, *Almborn* 6435 (LD); Natal: South of Nkandhla, Nkandhla, *Almborn* 8074 (LD), Impetyne Forest near Weza, Alfred, *Almborn* 9969 (LD), Indumeni Forest, Cathedral Peak Area, Bergville, *Almborn* 9191 (LD); Cape Province: Deepwall Forest, Knysna, *Arnell* 1632a, 1645 (LD), Table Mountain, *Arnell* 861 (LD), *Maas Geesteranus* 12167 (L), along Skeleton Stream, east slopes of Table Mountain, Wynberg, *Almborn* 11153 (LD), Fern Kloof, Albany, *Almborn* 10735 (LD).

20. Parmelia lineariloba Kurokawa, sp. nov. PLATE 6

Thallus adnatus, corticola, cinereo-albicans, 3–5 cm. diametro, lobis sublinearibus, elongatis, subdivaricatis, separatis, 0.5–2.0 mm. latis, superne planus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus niger, rhizinosus, rhizinis longis, nigris, sparse ramosis. Apothecia ignota.

Thallus adnate on bark, pale gull grey (R), 3–5 cm. in diameter; lobes dichotomously branched, linear-elongate, subdivaricate, separate, 0.5–2.0 mm. wide, 100–130 μ thick, the margins smooth, narrowly black-rimmed; upper surface plane and smooth, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, rhizinate, the rhizines black, long and sparsely branched, about 1 mm. long. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Type in Michigan State University, collected in pine forest at summit of Alto de la Bandera, Cordillera Central, La Vega, Dominican Republic, elev. 2800 m., Aug. 5, 1958, by C. Wetmore (no. 3475; isotype in US).

Parmelia lineariloba has sublinear lobes that are quite narrow, long, and usually subdivaricate. The rhizines are rather long and only moderately branched. The chemically related subdivaricate species *P. gigas* Kurokawa and *P. cervicornis* Tuck. are much larger in size. *Parmelia lineariloba* is at present known only from the Dominican Republic, where it is found at high elevations in pine forests. We might expect it to be common in similar habitats elsewhere in the West Indies.

Additional specimens examined: Dominican Republic: Ridge connecting La Rucilla and Pico Trujillo, Macisco Central, elev. 8000 ft., *Wetmore* 3599, 3628 (MSC, US).

21. Parmelia lividescens Kurokawa, sp. nov.

Thallus adnatus, corticola, cinereo-albicans, 5–10 cm. diametro, lobis sublinearibus, 1.5–3.0 mm. latis, margine subcrenatis, superne nitidulus, sorediatus, soraliis subterminalibus, subtus sparse rhizinosus, niger, rhizinis nigris, dichotome ramosis. Apothecia adnata, 2–3 mm. diametro; hymenium 40–50 μ altum; sporae 5–7$\times$9–11 μ.

Thallus adnate on bark, yellowish glaucous (R), 5–10 cm. across; lobes dichotomously branched, sublinear, separate at the circumference, 1.5–3.0 mm. wide, 140–180 μ thick, the margins subcrenate; upper surface shiny on younger lobes, dull and irregularly cracked on older lobes, sorediate, soralia orbicular, laminal and subterminal; medulla white; undersurface sparsely rhizinate, black, the rhizines black, dichotomously branched. Apothecia adnate, 2–3 mm. in diameter, disc saccardo's brown (R), radially split; hymenium 40–50 μ high; spores 5–7$\times$9–11 μ.

Reactions: Thallus K+ yellow; medulla K−, C+ red, KC+ red, P−, atranorine and olivetoric acid present.

Type in the Botanical Museum, Lund University, collected on bark, Polela Forest, Polela, Natal, Union of South Africa, Nov. 10, 1953, by Ove Almborn (no. 9490; isotype in US).

This species resembles *P. revoluta* Flk. in the presence of subterminal capitate soralia and in the absence of maculae. *Parmelia revoluta*, however, produces gyrophoric acid and has more sparsely branched rhizines. *Parmelia leiophylla* Kurokawa has the same chemical content as *P. lividescens* but differs in having laminal sorediate pustules.

Additional specimen examined: Union of South Africa: 6 mi. north of Knysna, Knysna, Cape Province, *Almborn* 2665 (LD).

22. Parmelia monilifera Kurokawa, sp. nov. PLATE 9

Thallus adnatus, corticola, cinereo-albicans, ca. 12 cm. diametro, lobis sublineari-elongatis, subdivaricatis, 2–6 mm. latis, superne planus, nitidus, emaculatus, isidiis sorediisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, ramosis, saepe moniliformibus. Apothecia ignota.

Thallus loosely adnate on bark, grayish white, about 12 cm. in diameter; lobes dichotomously branched, sublinear-elongate, subdivaricate, 2–6 mm. wide, 200–250 μ thick, the margins smooth; upper surface smooth, plane to concave, shiny, without maculae, isidia and soredia lacking; medulla white; undersurface black, densely rhizinate, the rhizines black, shiny, branched, often moniliform or opuntioid, projecting as a mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C− or C+ pale orange, KC+ deep orange red, P−, atranorine, barbatic acid, and an unknown KC+ substance present.

Type in the Botanische Staatssammlung, Munich, collected at La Aguada, Mérida, Venezuela, Apr. 2, 1958, by K. Mägdefrau (no. 651; isotype in US).

This species resembles *P. gigas* Kurokawa, *P. cervicornis* Tuck., and *P. exporrecta* Kurokawa in having a large divaricate thallus and sublinear-elongate lobes. It is clearly separated by the coarse, branched, moniliform or opuntioid rhizines, a type that we have not seen in any other species of *Parmelia*. It is especially distinct chemically, since related species have alectoronic acid, or less commonly gyrophoric acid. The species is known only from the type locality in Venezuela.

23. Parmelia prolongata Kurokawa, sp. nov. PLATE 6

Thallus laxe adnatus, corticola, olivaceo-albicans, 5–10 cm. diametro, lobis sublinearibus, 1.5–4.0 mm. latis, margine partim isidiato-dissectis, superne planus, nitidus, exigue albomaculatus, sparse isidiatus, medulla alba vel pallide flavescens, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, sea-foam yellow (R) turning olive buff in the herbarium, 5–10 cm. across; lobes dichotomously branched, sublinear, elongate, sometimes subimbricate, 1.5–4.0 mm. wide, 100–200 μ thick, the margins smooth or in part with isidial branchlets or isidia, often elongate, ascending or suberect, dorsiventral or becoming cylindrical and coralloid branched; upper surface plane and smooth, weakly maculate, rather shiny, often sparsely isidiate, the isidia cylindrical, variable, sometimes branched; medulla white to cartridge buff (R); undersurface black, densely rhizinate, the

rhizines black, shiny, densely branched, often forming a mat. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ deep red, KC+ red, P−, atranorine, a C+ unknown substance, and frequently a pale-yellowish pigment present.

Type in Michigan State University, collected on ridge leading to Pic Macaya, Morne Macaya, Dept. du Sud, Haiti, elev. 6400–7000 ft., July 27, 1958, by C. Wetmore (no. 3233; isotype in US).

Parmelia prolongata is characterized by peculiar laminal and marginal isidia which are cylindrical at first but which at length become dorsiventral, suberect, and more or less branched, and as much as 5 mm. long. However, the production of isidia and lobules is extremely variable and they may be reduced to small marginal isidia. All specimens have in common a deep C+ reaction caused by an unknown substance apparently related to olivetoric or anziaic acid. The pale-yellow pigment may or may not be clearly present and its identity is unknown. *Parmelia prolongata* is found at higher elevations, often on conifer bark, in the Caribbean and Andean regions.

Additional specimens examined: Mexico: Chiapas: 18 km. southeast of San Cristóbal, *Hale* 20286 (US). Panama: Prov. Chiriquí: East side of Volcán Chiriquí, *Scholander*, Dec. 5–12, 1948 (US). Haiti: Ridge leading to Pic Macaya, Morne Macaya, Dept. du Sud, elev. 6400–7000 ft., *Wetmore* 3233 (MSC, US), 3286 (MSC). Colombia: Western slopes of Páramo de Cruz Verde, Dept. Cundinamarca, 3150 m., *Cuatrecasas* 450Z (US).

24. Parmelia rhabdiformis Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-albicans in herbario, ca. 8 cm. diametro, lobis sublinearibus, 2–6 mm. latis, subimbricatis, margine plus minusve dissectis, superne planus, nitidus, emaculatus, isidiatus, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia adnata, 1–5 mm. diametro; hymenium 60–80 μ altum; sporae 6–8$\times$15–21 μ.

Thallus adnate on bark, turning cream buff (R) in the herbarium, about 8 cm. in diameter; lobes irregularly branched, sublinear, 2–6 mm. wide, subimbricate, 150–200 μ thick, the margins more or less dissected; upper surface plane, shiny, without maculae, isidiate, the isidia mostly simple, club-shaped, about 0.5 mm. high; medulla white; undersurface black, densely rhizinate, the rhizines black, densely and finely branched, forming a woolly mat. Apothecia adnate, 1–5 mm. in diameter, exciple crenate, amphithecium isidiate, disc sayal brown (R), sometimes radially split; hymenium 60–80 μ high; spores 6–8$\times$15–21 μ.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and norstictic acid present.

Type in the U.S. National Herbarium, collected in the vicinity of El Boquete, Prov. Chiriquí, Panama, Mar. 2, 1911, by W. R. Maxon (no. 5128a).

Except for the production of norstictic acid, this species resembles *P. infirma* Kurokawa and *P. crenata* Kurokawa, both Asian species. The isidia of *P. rhabdiformis* are mostly simple and clavate and rather elongate, to 0.5 mm. high. It is known only from the type locality in Panama.

25. Parmelia rigidula Kurokawa, sp. nov.

Thallus adnatus, corticola, olivaceo-cinerascens, 7–12 cm. diametro, lobis sublinearibus vel subirregularibus, subimbricatis, usque ad 7 mm. latis, margine subcrenatis, superne nitidulus, exigue albomaculatus vel emaculatus, sorediis isidiisque destitutus, medulla pallide flavicans, subtus niger, rhizinosus, rhizinis nigris, modice ramosis. Apothecia adnata, 2–7 mm. diametro; hymenium 70–85 μ altum; sporae 10–12×15–18 μ.

Thallus adnate on bark, pale olive buff (R), 7–12 cm. in diameter; lobes irregularly branched, sublinear to subirregular, more or less imbricate, up to 7 mm. wide, 210–250 μ thick, the margins crenate, often narrowly black-rimmed; upper surface plane to concave, more or less shiny, weakly maculate or without maculae; medulla sea-foam yellow to pale-pinkish buff (R), K−; under surface black, moderately rhizinate, the rhizines black, matted, sparsely to moderately branched. Apothecia adnate, 2–7 mm. diameter, exciple smooth to undulate, disc dark livid-brown (R), sometimes radially split; hymenium 70–85 μ high; spores 10–12×15–18 μ.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and a pale-yellow pigment present.

Type in the National Science Museum, Tokyo, collected at Phalut, Darjeeling, India, June 6, 1960, by H. Hara (isotype in US).

This species has a peculiar coriaceous thallus as in *P. scytodes* Kurokawa and *P. scytophylla* Kurokawa. However, it is distinguished by producing a pale-yellow-orange pigment in the medulla (apparently not entothein). Superficially it resembles *P. subaurulenta* Nyl., but the rhizines are sparsely to moderately branched, not simple. Only two specimens have been collected, both in northern India, where it is endemic.

Additional specimen examined: India: Tongloo, Himalayas, *Watt* 7035 (BM).

26. Parmelia scytodes Kurokawa, sp. nov. PLATE 6

Thallus adnatus vel laxe adnatus, corticola, cinereo-albicans, ca. 20 cm. diametro, lobis sublinearibus, 2–5 mm. latis, superne planus, emaculatus, isidiis sorediisque destitutus, subtus niger, dense rhizinosus, rhizinis nigris, modice ramosis. Apothecia ignota.

Thallus adnate to loosely adnate on bark, rather coriaceous, pale smoke gray (R), about 20 cm. across; lobes irregularly branched, sublinear, 2–5 mm. wide, 150–200 μ thick, the margins subcrenate, narrowly black-rimmed; upper surface plane and smooth, becoming rugose on older lobes, without maculae, isidia and soredia lacking; medulla white; undersurface black, moderately to densely rhizinate, the rhizines black, shiny, moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange, P+ orange red, atranorine, barbatic acid, and an unidentified P+ acid present.

Type in the National Science Museum, Tokyo, collected at Darjeeling, Batasi, India, May 6, 1960, by Togashi (isotype in US).

This new species is characterized by the large rather coriaceous thallus. Externally it resembles *P. fissicarpa* Kurokawa, an African species with a P+ reaction but no barbatic acid. *Parmelia bostrychodes* Zahlbr. and *P. physcioides* Nyl., both of which produce barbatic acid without a P+ substance, have smaller sublinear lobes. *Parmelia scytodes* is known only from the type locality in India.

27. Parmelia scytophylla Kurokawa, sp. nov. PLATE 7

Thallus adnatus, corticola, cinereo-albicans, 5–14 cm. diametro, lobis sublinearibus vel subirregularibus, margine subcrenatis, superne planus, nitidus, exigue albomaculatus, isidiis sorediisque destitutus, subtus niger, modice rhizinosus, rhizinis nigris, sparse ramosis. Apothecia adnata, ca. 10 mm. diametro; hymenium 35–40 μ altum; sporae 5–6$\times$8–9 μ.

Thallus adnate to loosely adnate on bark, yellowish glaucous to pale olive gray (R), 5–14 cm. in diameter; lobes irregularly branched, sublinear to subirregular, 2–6 mm. wide, 250–350 μ thick, the margins more or less crenate, narrowly black-rimmed; upper surface plane and smooth, shiny, faintly maculate, isidia and soredia lacking; medulla white; undersurface black, moderately rhizinate, blackish brown and naked or papillate in a narrow zone around the tips, the rhizines black, shiny, sparsely branched. Apothecia adnate to substipitate, often more than 10 cm. in diameter, exciple undulate, amphithecium smooth, faintly maculate, disc warm blackish brown to light seal brown (R); hymenium 35–40 μ high; spores 5–6$\times$8–9 μ.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Type in the National Science Museum, Tokyo, collected at Migotang, Sikkim, at 3900 m. elevation, May 30, 1960, by H. Hara (isotype in US).

Parmelia scytophylla is very similar to two other species known only in the Himalayan region, *P. rigidula* Kurokawa and *P. scytodes* Kurokawa. All have rather large coriaceous thalli. *Parmelia scytodes* contains barbatic acid and a P+ unknown, and *P. rigidula* contains a pale-yellow pigment and has larger spores, 15–18 μ long.

Additional specimens examined: Nepal: Langtang Village, *Polunin* M32 (BM). India: Nilgherries, *Watt* s.n. (BM); Darjeeling, *Awasthi* 12 (H).

28. Parmelia thysanota Kurokawa, sp. nov.

Thallus laxe adnatus, corticola, cinereo-albicans, 5–13 cm. latus, lobis sublinearibus, subdivaricatis, separatis, 2–5 mm. latis, superne planus, nitidulus, apice leviter albopruinosus, sorediatus, soraliis subterminalibus, subtus niger, dense rhizinosus, rhizinis nigris, dense ramosis. Apothecia ignota.

Thallus loosely adnate on bark, pale-glaucous green (R), 5–13 cm. in diameter; lobes dichotomously branched, linear or sublinear-elongate, subdivaricate, separate at the circumference, 2–5 mm. wide, 140–180 μ thick, the margins entire, narrowly black-rimmed; upper surface plane, rather shiny, often pruinose near the tips, sorediate, soralia laminal and subterminal, often protruding, coalescing; medulla white; undersurface densely rhizinate, black, the rhizines black, shiny, densely branched, usually projecting in a narrow dense mat beyond the margins. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Type in the United States National Herbarium, collected in pine-oak forest on lava, 11 km. east of Las Vigas on Highway 140, Veracruz, Mexico, Mar. 11, 1960, by M. E. Hale (no. 20943).

Parmelia thysanota is very closely related to *P. exporrecta* Kurokawa in having a subdivaricate thallus and in producing gyrophoric acid. It differs in having subterminal soralia; *P. exporrecta* lacks any soralia. It is probable that these two species represent a sorediate-nonsorediate phase, but the material at hand is not sufficient for a final decision.

Additional specimen examined: Mexico: Same locality data as the holotype, *Hale* 21118 (US).

29. Parmelia virginica Hale, sp. nov. PLATE 5

Thallus adnatus, albido-cinerascens, nonnihil fragilis, corticola, 5–7 cm. diametro, lobis sublinearibus, 1.5–2.5 mm. latis, margine centrum versus paulo lobulato-dissectis, superne nitidus, minute

rugulosus, aetate valde irregulariter rugosus, cortice fragili, pustulescente, sorediis destitutus, subtus niger, modice rhizinosus, rhizinis modice dichotome ramosis. Apothecia ignota.

Thallus adnate, mineral gray, rather fragile, corticolous; lobes sublinear, 1.5–2.5 mm. wide, 110–130 μ thick, more or less subimbricate, towards the center lobulate-dissected; upper surface shiny, minutely rugulose, strongly rugose with age, the cortex fragile and breaking away, forming coarse pustules, soredia lacking; medulla white; undersurface black, brown near the tips, moderately rhizinate, the rhizines black, moderately branched. Apothecia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange, P−, atranorine, barbatic acid, and an unknown KC+ substance present.

Type in the U.S. National Herbarium, collected at Hawksbill, Shennandoah National Park, Page Co., Virginia, elev. 1200 m., June 26, 1962, by M. Hale (no. 21592; isotypes in DUKE, LD, M, MSC, REN, S, TNS, WISC).

Parmelia virginica is virtually identical with *P. taylorensis* Mitch. (*P. rugosa* Tayl. non Fr.) in regard to the fragile cortex and the development of pustules. The pustules originate along the ridges of wrinkles and are therefore usually elongate. *Parmelia taylorensis* (cf. Mitchell, 1962; Hale, 1962) is typically a European species which differs in having evernic and lecanoric acids and more richly branched rhizines. The type collection of *P. virginica* was made on exposed dwarf spruce trunks. It is probably common in similar habitats in the Appalachians from Virginia through North Carolina.

Additional specimen examined: North Carolina: Lich-Log ridge, Blue Ridge Parkway, McDowell Co., elev. 4660 ft., *Becking* 5908031 (US).

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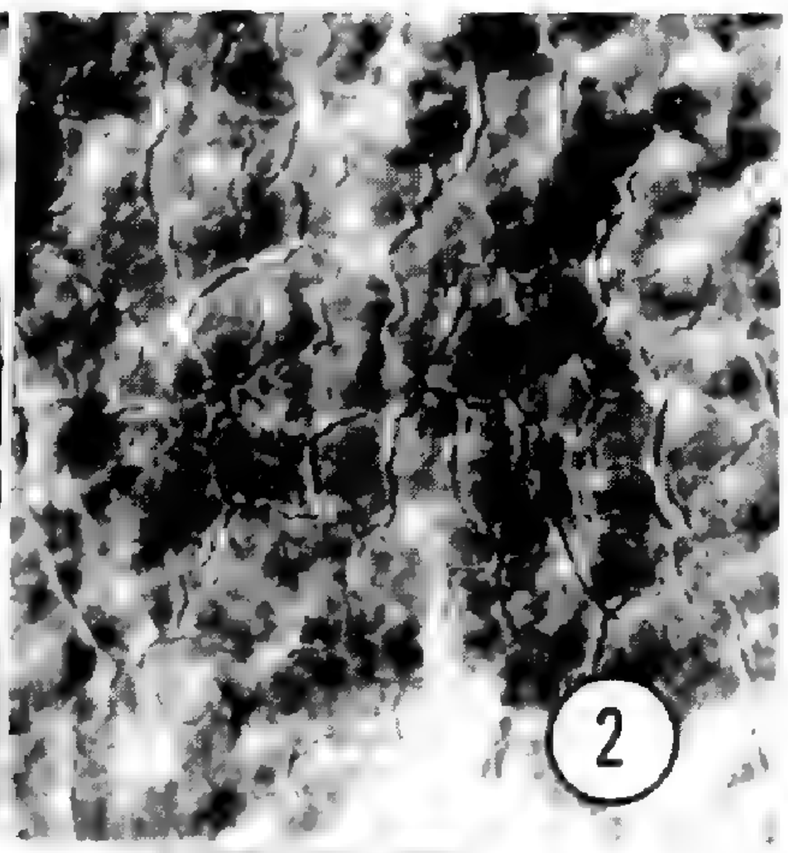

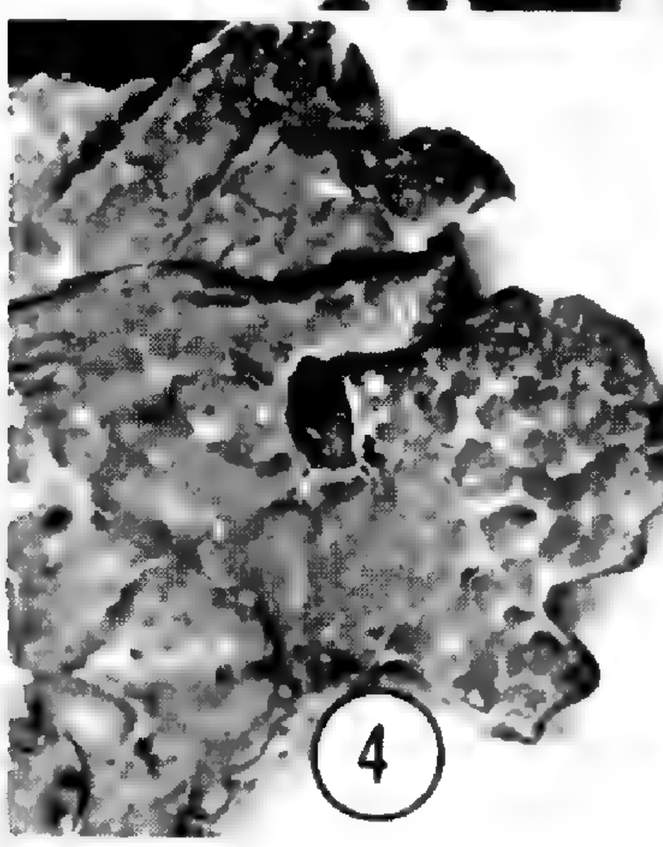

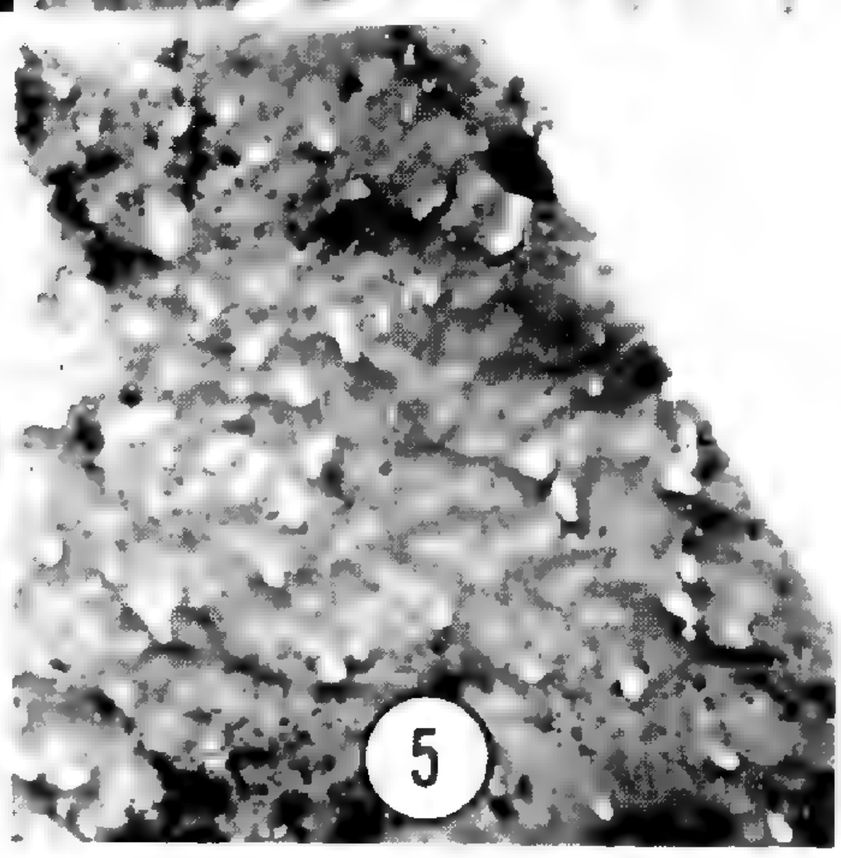

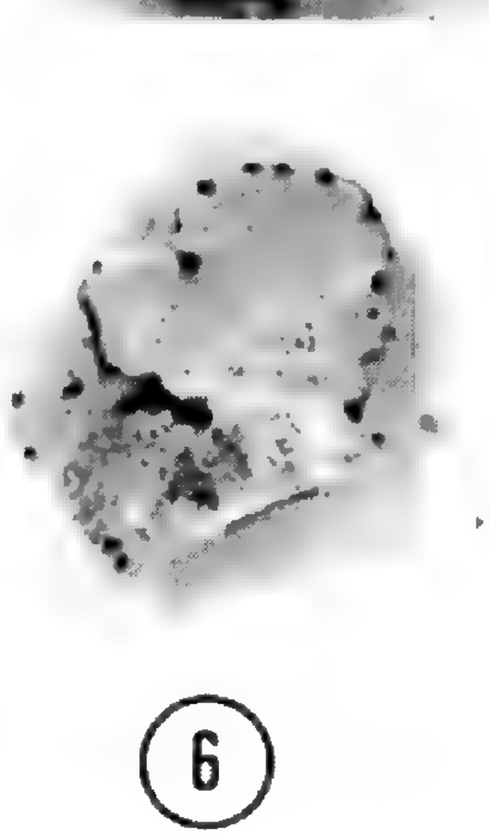

1. Pustules of *Parmelia aurulenta* Tuck. (×10). 2. Reticulate upper cortex of *Parmelia reticulata* Tayl. (×10). 3. Marginal cilia of *Parmelia melanochaeta* Kurokawa (×5). 4. Effigurate pseudocyphellae of *Parmelia saxatilis* (L.) Ach. (×5). 5. Pseudocyphellae of *Parmelia subrudecta* Nyl. (×5). 6. Bulbate cilia of *Parmelia tabacina* Mont. & v.d. Bosch. (×5). 7. *Parmelia bulbochaeta* Hale (isotype, *Awasthi* 4347, US, ×2).

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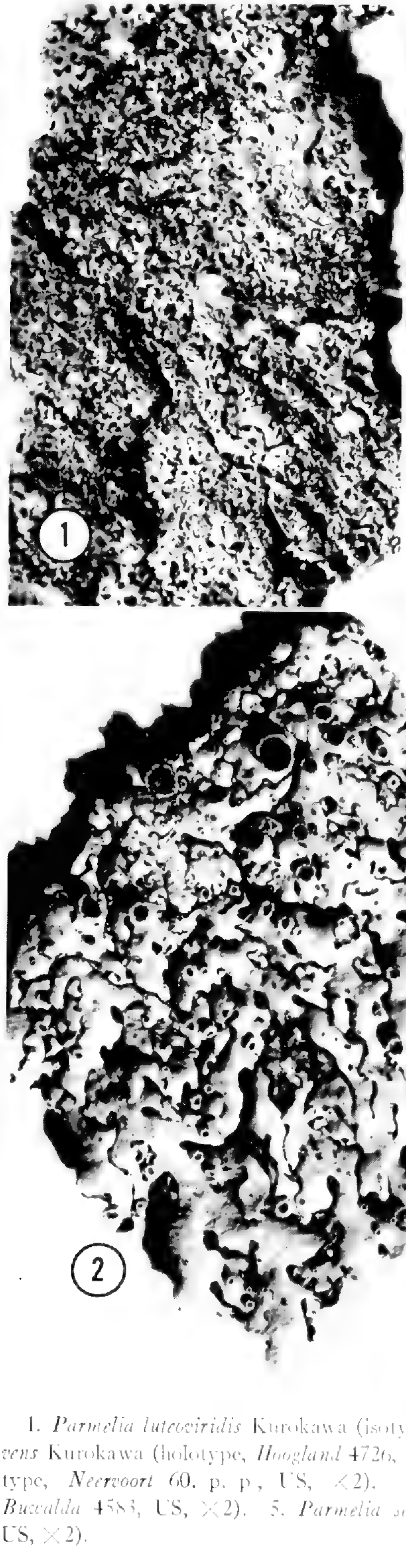
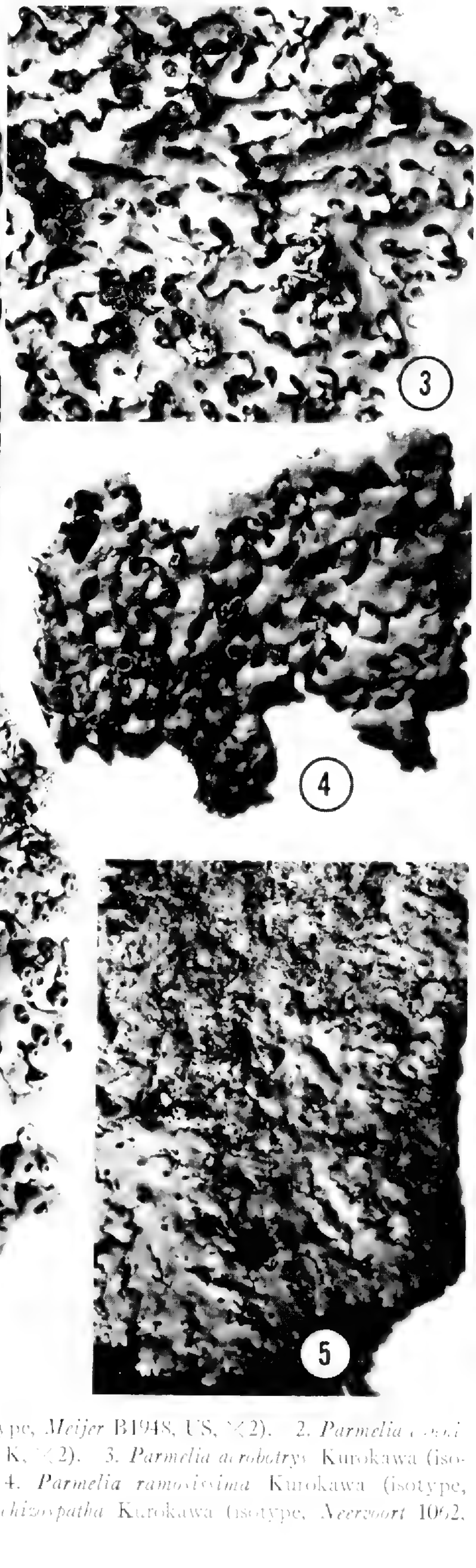
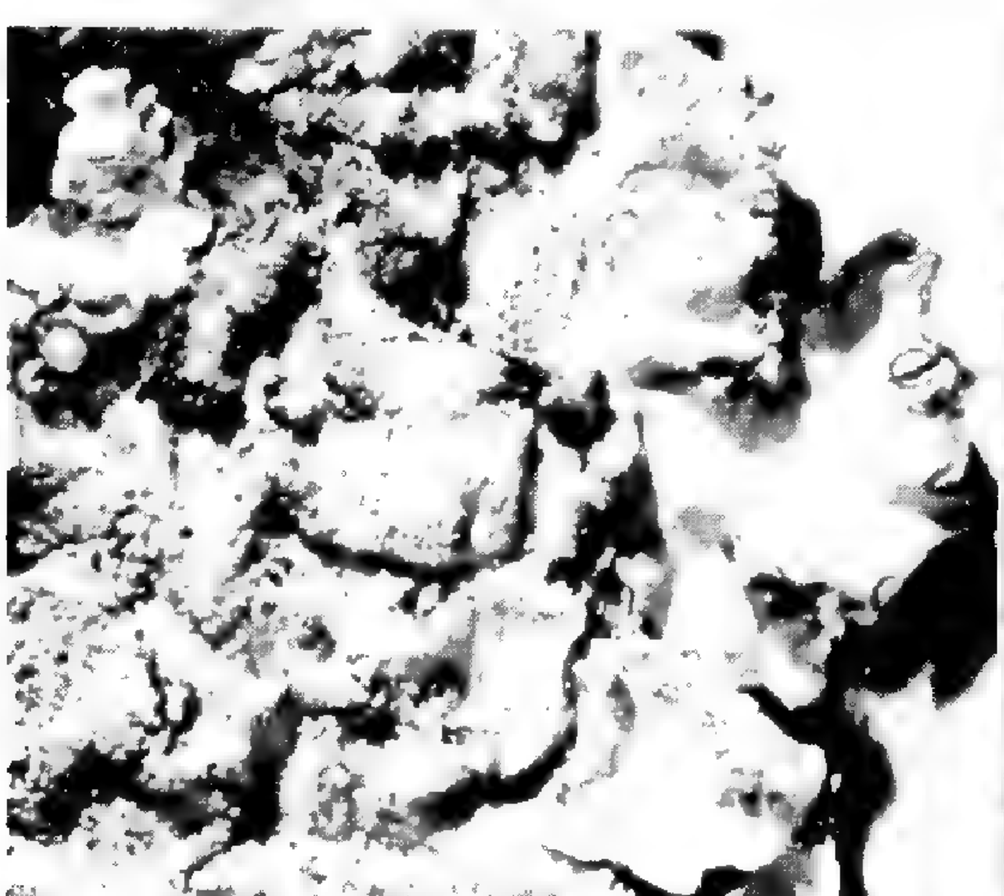
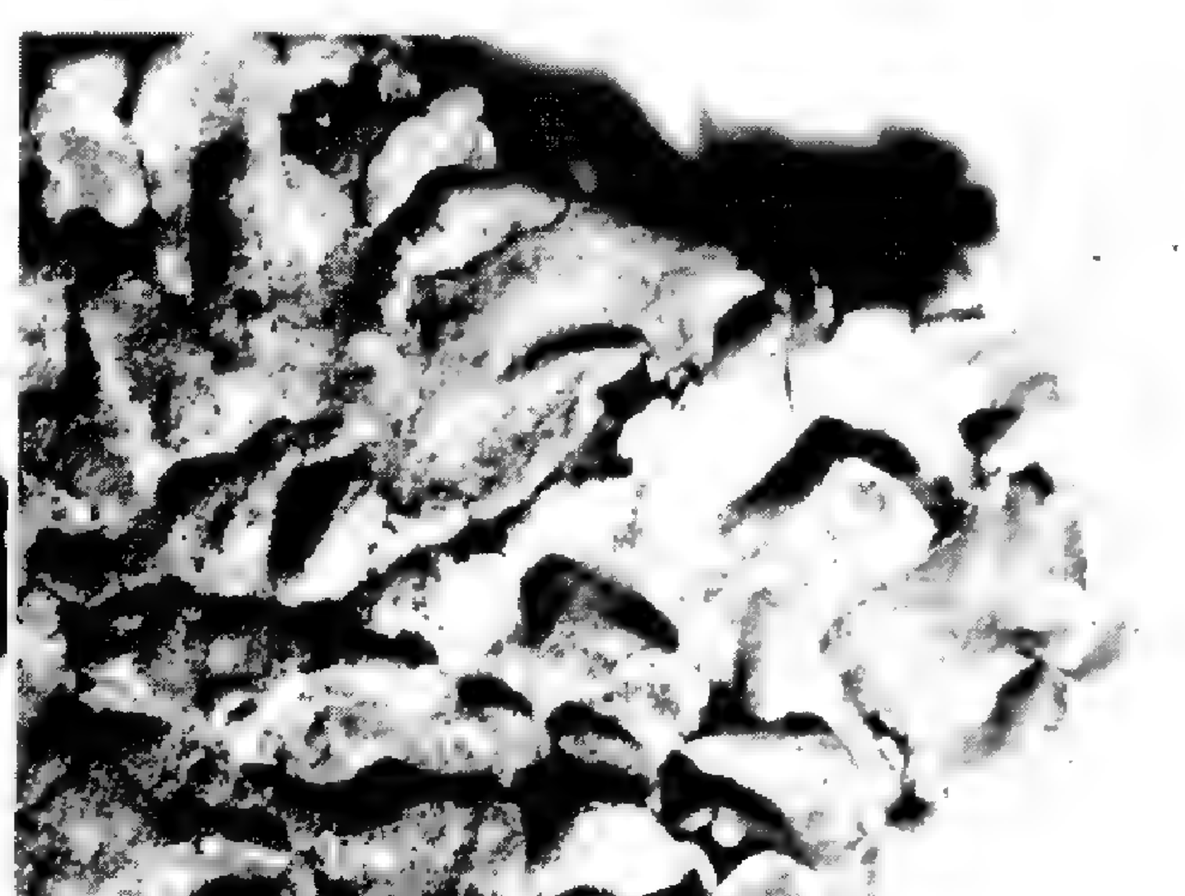


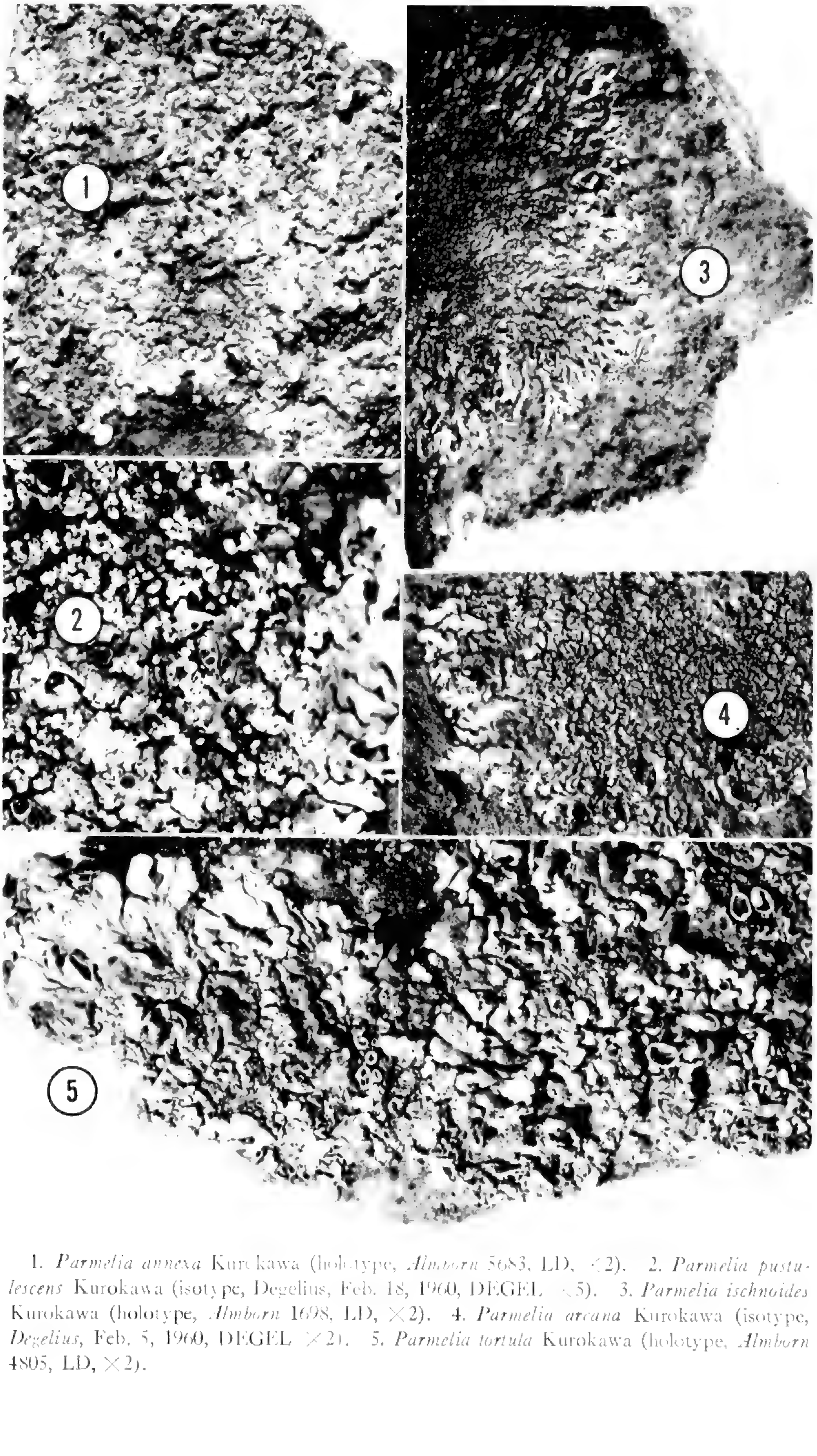


1. *Parmelia luteoviridis* Kurokawa (isotype, *Meijer* B1948, US, ×2). 2. *Parmelia [illegible] vens* Kurokawa (holotype, *Hoogland* 4726, K, ×2). 3. *Parmelia acrobotrys* Kurokawa (isotype, *Neervoort* 60, p. p., US, ×2). 4. *Parmelia ramosissima* Kurokawa (isotype, *Buccalda* 4583, US, ×2). 5. *Parmelia schizopatha* Kurokawa (isotype, *Neervoort* 1062, US, ×2).

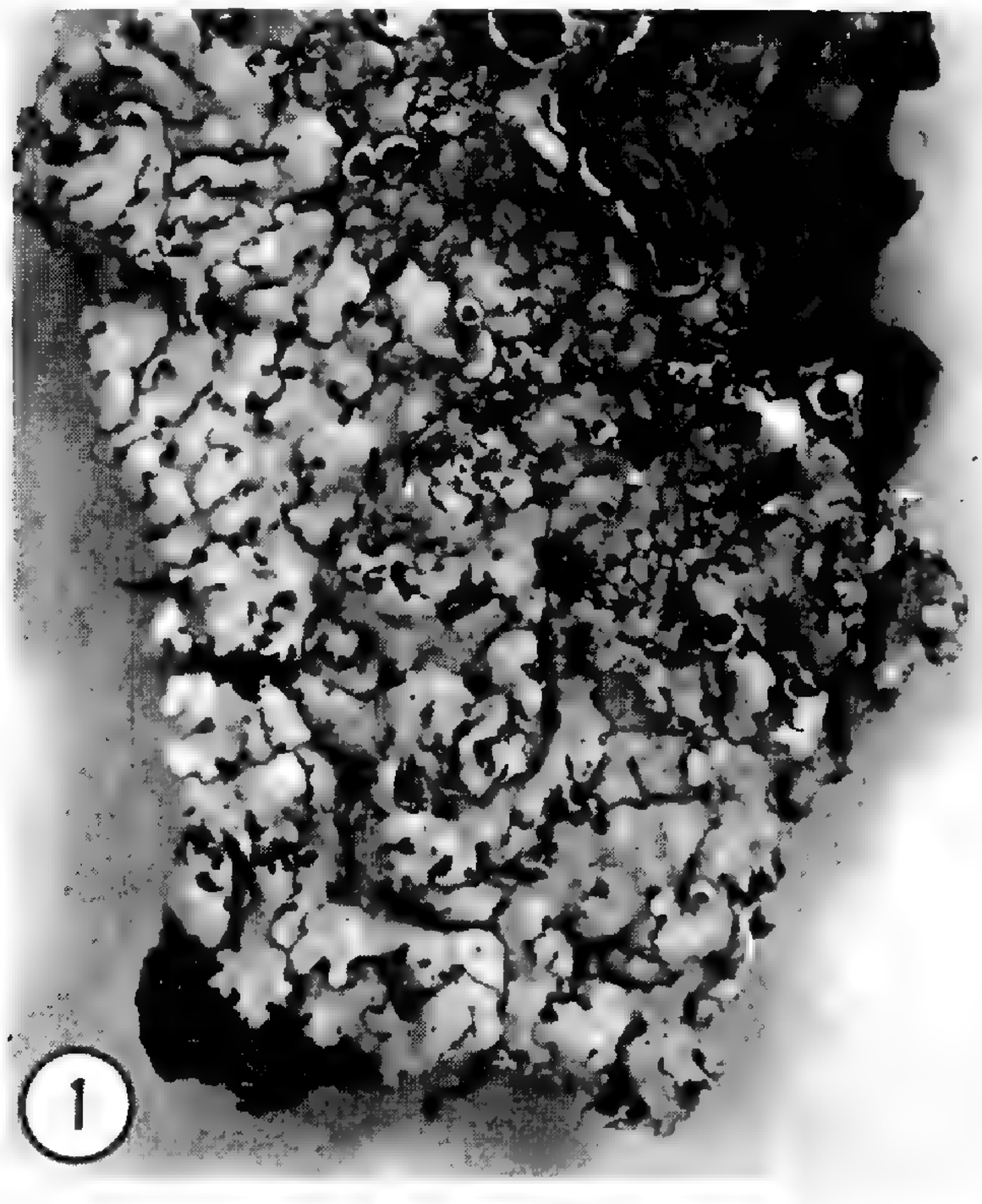


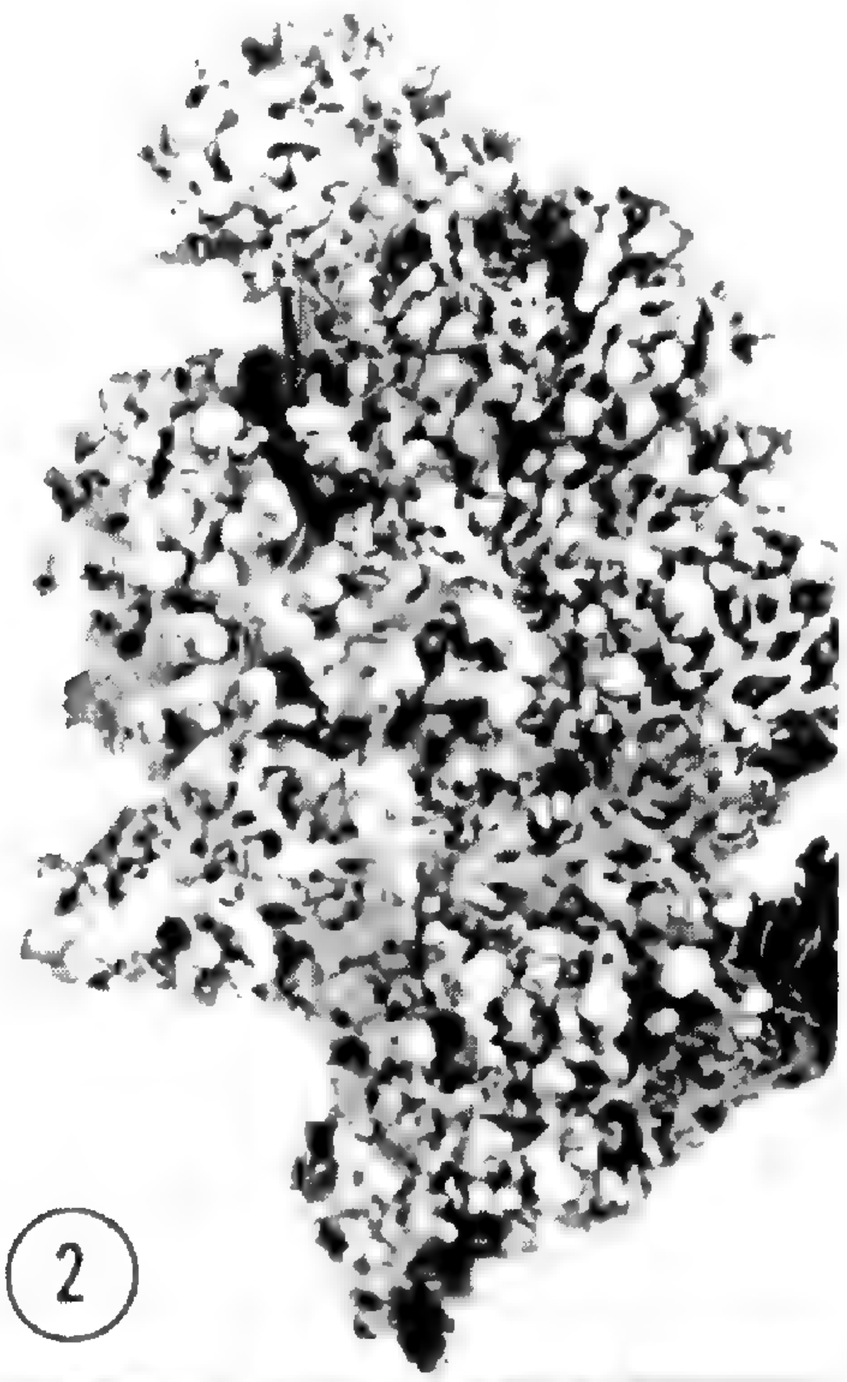


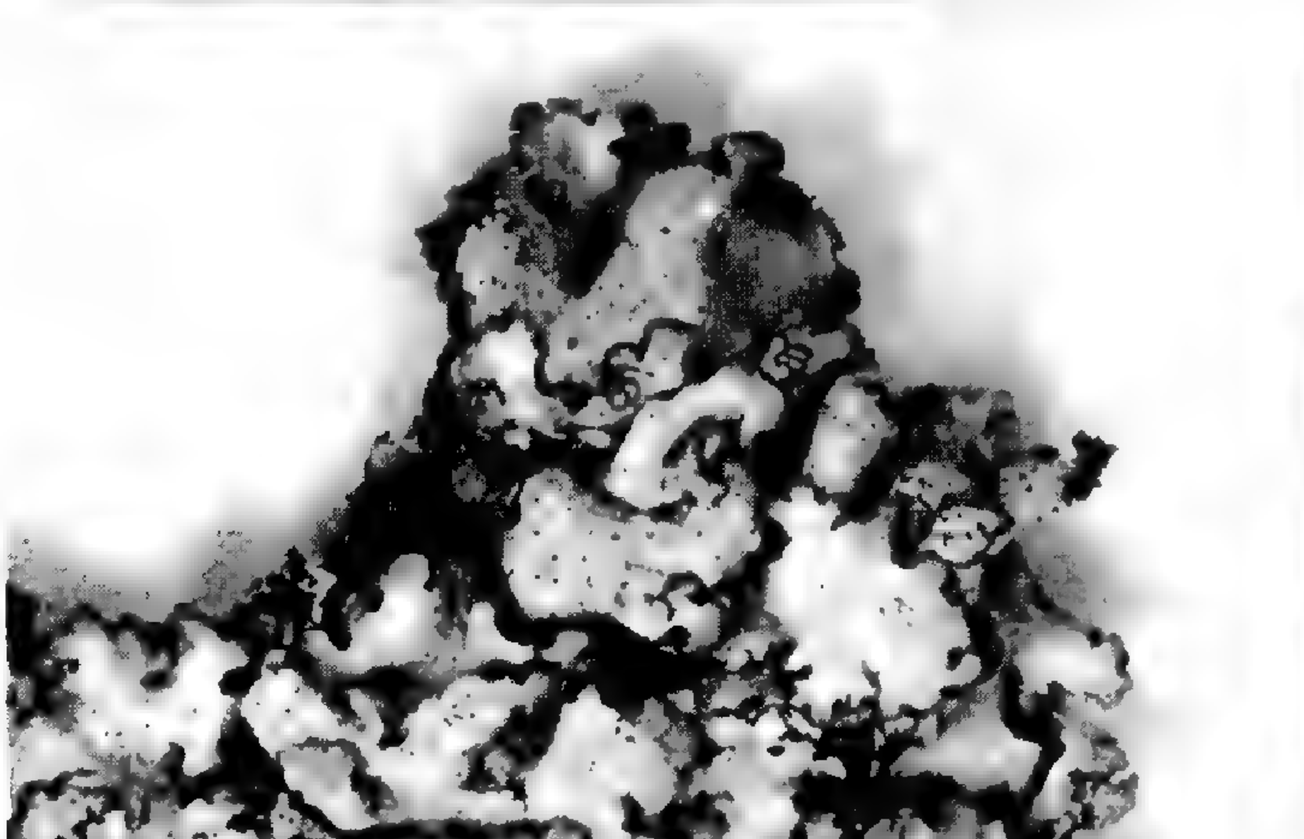
1. *Parmelia caribaea* Hale (isotype, *Le Gallo* 494, US, ×2). 2. *Parmelia brevirhiza* Kurokawa (holotype, *Santesson* 2066, S, ×1). 3. *Parmelia eruptens* Kurokawa (isotype, *Almborn* 7498, LD, ×2). 4. *Parmelia melanochaeta* Kurokawa (holotype, *Malme* 2243, S, ×2).

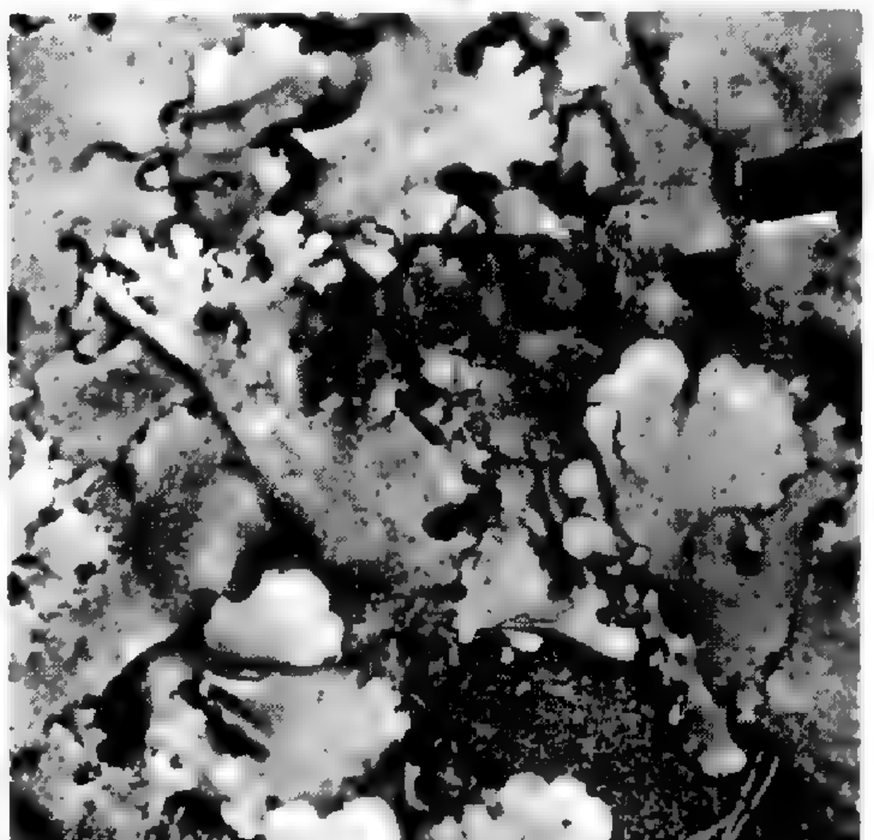


1. *Parmelia annexa* Kurokawa (holotype, *Almborn* 5683, LD, ×2). 2. *Parmelia pustulescens* Kurokawa (isotype, Degelius, Feb. 18, 1960, DEGEL ×5). 3. *Parmelia ischnoides* Kurokawa (holotype, *Almborn* 1698, LD, ×2). 4. *Parmelia arcana* Kurokawa (isotype, *Degelius*, Feb. 5, 1960, DEGEL ×2). 5. *Parmelia tortula* Kurokawa (holotype, *Almborn* 4805, LD, ×2).

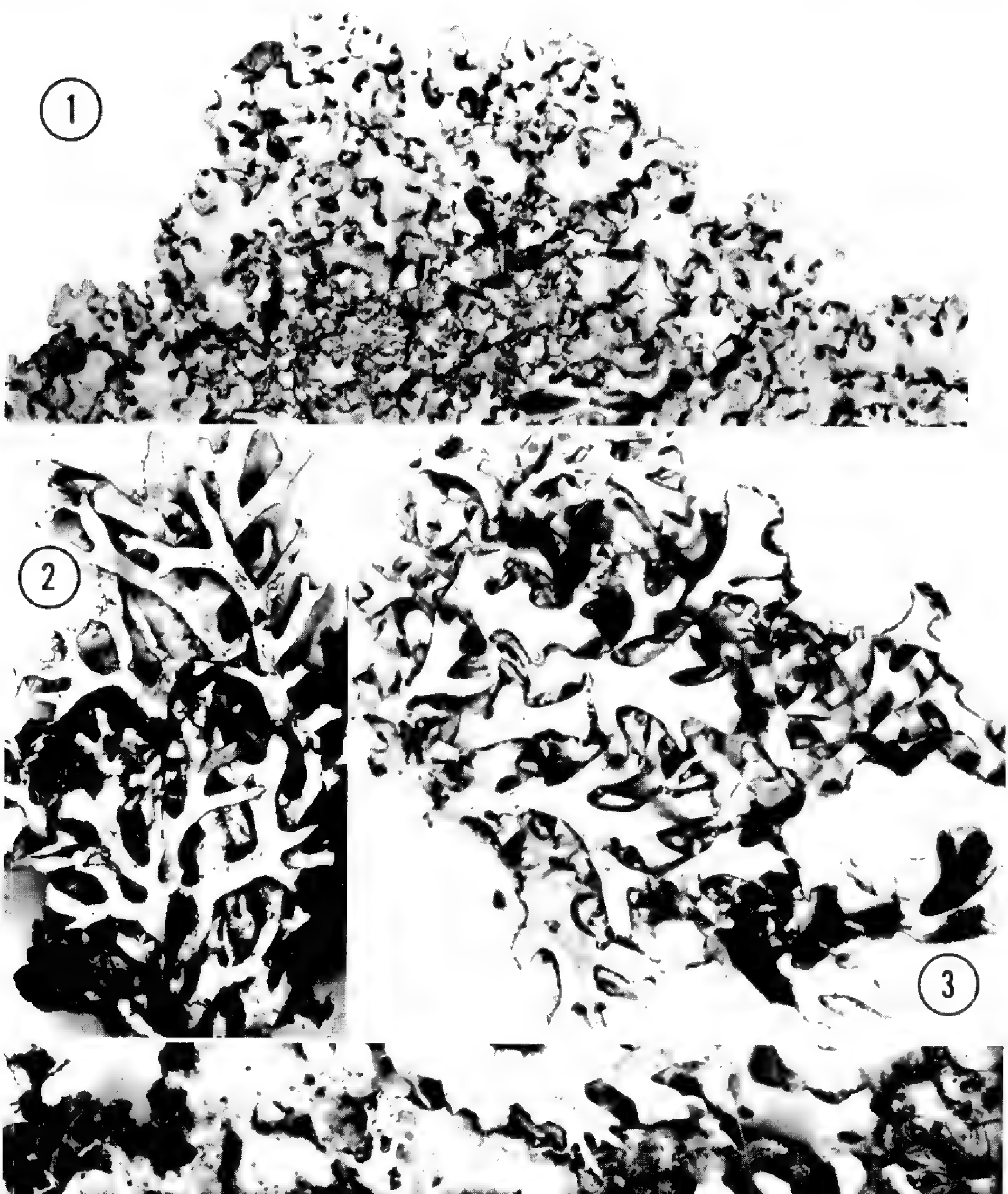




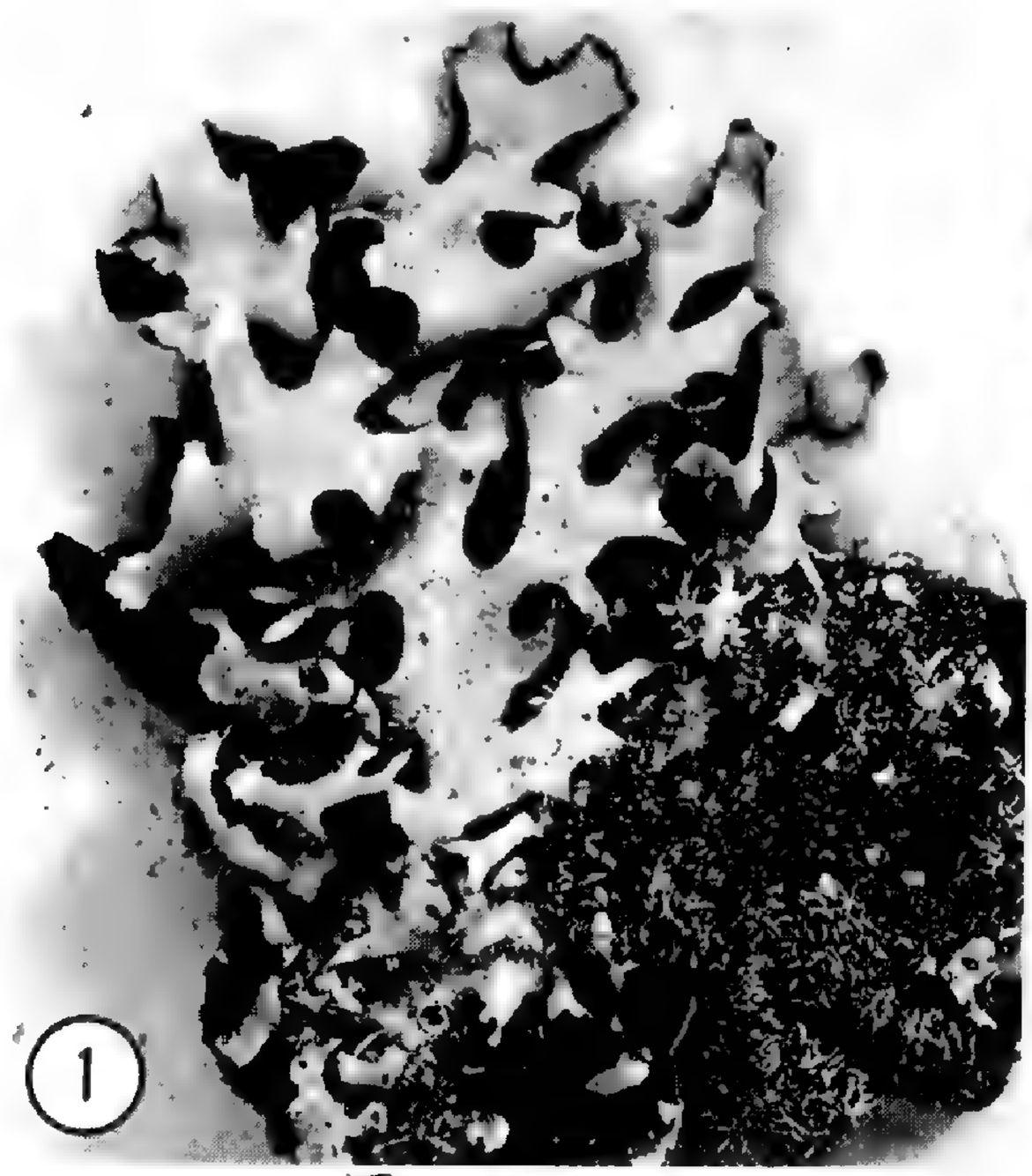


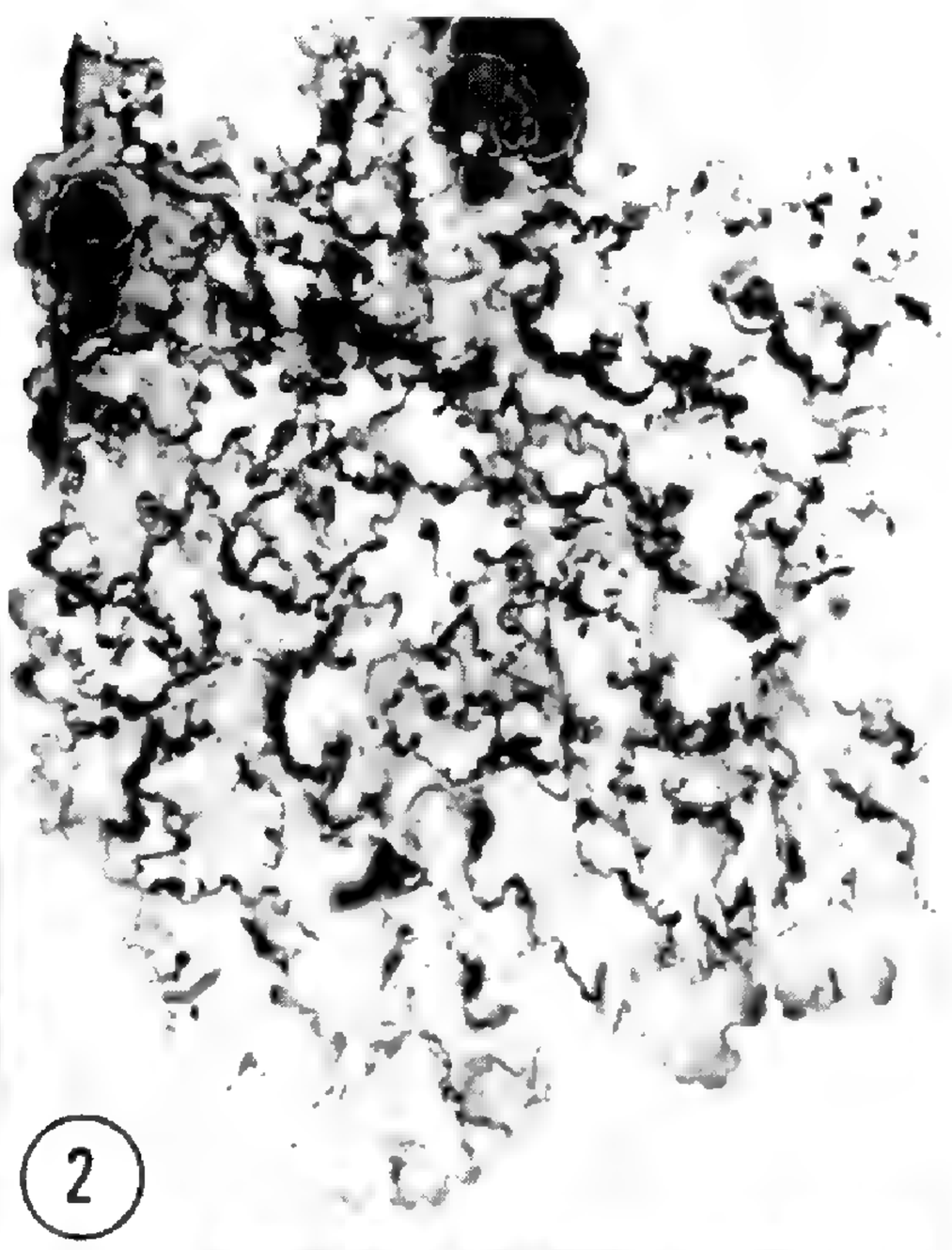


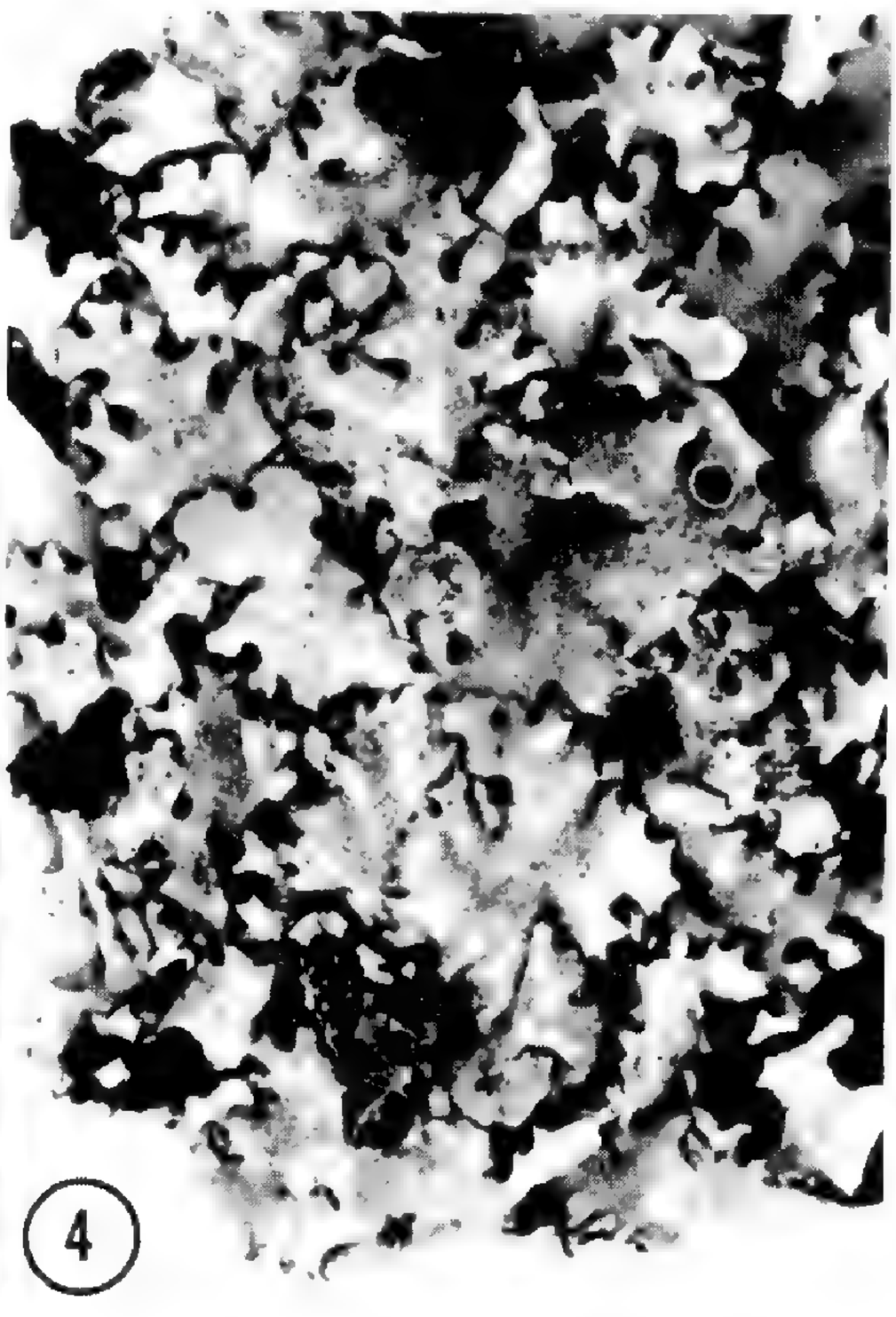
1. *Parmelia degelii* Hale (holotype, *Degelius*, Feb. 16, 1960, DEGEL, ×2). 2. *Parmelia anaptychioides* Kurokawa (holotype, *Wetmore* 3617, MSC, ×1¼). 3. *Parmelia virginica* Hale (holotype, *Hale* 21592, US, ×2). 4. *Parmelia dentella* Hale & Kurokawa (holotype, *McCullough* 570, US, ×2).



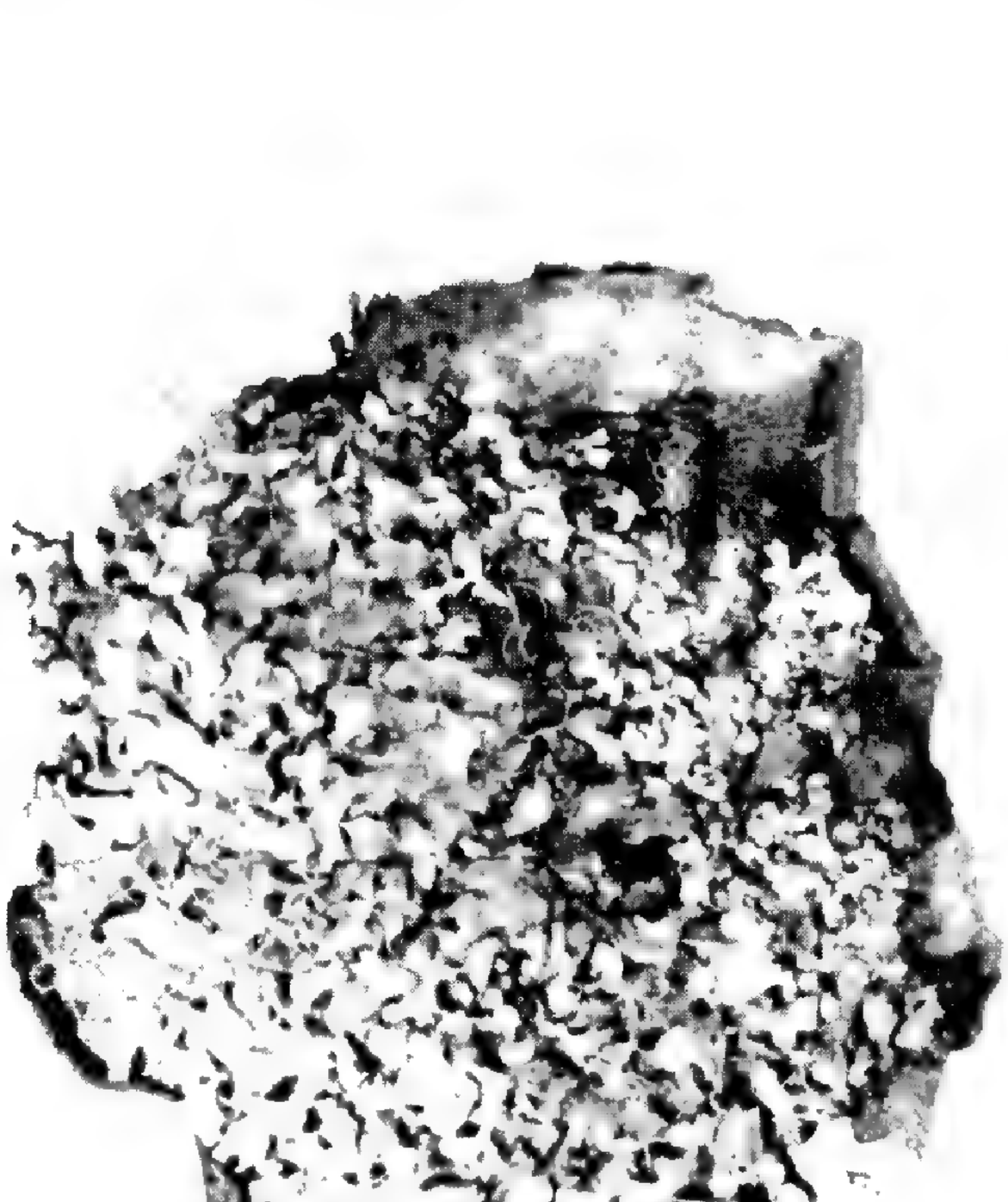
1. *Parmelia scytodes* Kurokawa (isotype, *Togashi*, May 6, 1960, US, ×1). 2. *Parmelia lineariloba* Kurokawa (holotype, *Wetmore* 3475, MSC, ×2). 3. *Parmelia exporrecta* Kurokawa (holotype, *Hale* 20722, US, ×1). 4. *Parmelia prolongata* Kurokawa (holotype, *Wetmore 3233*, MSC, ×4).







1. *Parmelia ensifolia* Kurokawa (detail showing lobules) (holotype, *Imshaug* 23430, MSC, ×2). 2 *Parmelia scytophylla* Kurokawa (isotype, *Hara*, May 30, 1960, US, ×1). 3. *Parmelia fissicarpa* Kurokawa (holotype, *Almborn* 9374, LD, ×1). 4. *Parmelia infirma* Kurokawa (isotype, *Hara*, Apr. 12, 1960, US, ×2).



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1. *Parmelia flavovirens* Kurokawa (holotype, *Santesson* 5681, S, ×1¼). 2. *Parmelia densirhizinata* Kurokawa (holotype, *Scholander*, Dec. 5 12, 1948, US, ×3/4). 3. *Parmelia gigas* Kurokawa (holotype, *Ariste* B70, US, ×1).

1. *Parmelia monilifera* Kurokawa (holotype, *Magdefrau* 651, M, ×1). 2. *Parmelia croceopustulata* Kurokawa (holotype, *Imshaug* 22275, MSC, ×1). 3. *Parmelia leiophylla* Kurokawa (holotype, *Almborn* 6796, LD, ×3/4). 4. *Parmelia salacinifera* Hale (holotype, *Rapp* March 1925, US, ×1).

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A MONOGRAPH OF PARMELIA SUBGENUS AMPHIGYMNIA

By MASON E. HALE, JR.

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A MONOGRAPH OF PARMELIA SUBGENUS AMPHIGYMNIA

By Mason E. Hale, Jr.

Introduction

Parmelia has strangely been overlooked in the recent burst of monographic activity in lichens. It is a common, easily recognized foliose genus, well represented in most herbaria, with over 1,000 names in the literature. Traditionally the European lichenologists have passed it over as an "easy" genus and concentrated on the more difficult crustose groups. It must be understood, of course, that Europe has a very poor *Parmelia* flora, especially in Amphigymnias, certainly not one to attract the attention of a serious monographer.

This monograph deals only with subgenus *Amphigymnia* (Vain.) Dodge, a remarkably homogeneous group of 106 species. Studies are concurrently under progress on subgenus *Parmelia* (Hale & Kurokawa, 1964) and subgenus *Xanthoparmelia* (Vain.) Hale, two distinct groups with approximately 275 and 80 species, respectively. As here delimited, *Amphigymnia* is characterized by broad, more or less rotund lobes, 6 to 20 mm. wide, bearing unbranched, often sparse and coarse rhizines on the lower side, with a broad distinct bare zone around the margins. The apothecia are typically pedicellate and rather often have perforate discs, characters virtually unknown in other groups of the genus. The species are not difficult to separate; characters of an absolute or qualitative nature predominate. There is little of the troublesome intergradation between species that makes genera such as *Usnea* or *Collema* so difficult.

Some overlap and intergradation occurs between a few *Amphigymnia* species and those of subgenus *Parmelia*, especially sections *Irregulares* (Vain.) Vain. and *Cyclocheila* (Vain.) Räs., which may have rotund (not linear) lobes and a distinct though narrow, bare zone below. An excellent example is *P. caperata* (L.) Ach., a well-known species formerly placed in subgenus *Amphigymnia* but apparently better put into subgenus *Parmelia* (cf. Hale & Kurokawa, 1964). As a result, we have relieved ourselves of these problems here and concentrated in subgenus *Amphigymnia* a very homogeneous group of species.

The methods of study in this monograph were first to survey the literature as completely as possible and second to examine as many holotypes as possible. Most of the original descriptions were reproduced by photostat and assembled in notebooks for rapid reference. All references were taken from the original publications. Proper citations of the specimens and the location of the types were determined and the available type specimens examined.

Personal fieldwork has included studies of the flora in much of the United States, especially from Virginia to Texas, eastern Canada, and southern Mexico. About half of the 106 species were actually observed in the field. Fortunately, contemporary lichenologists have made extensive and excellent collections in the West Indies (Plitt, Imshaug, Wetmore), Chile (Santesson), Africa (Almborn, Degelius, des Abbayes, Maas Geesteranus, Höeg), Java (Groenhart), and Japan (Asahina, Kurokawa). The most serious gaps are in tropical South America, Australia, the Philippines, Borneo, New Guinea, and China. It is estimated that exhaustive fieldwork would turn up another 10 or 20 new species, but it is doubtful that the subgenus will ever be found to contain more than 130 species, at least as delimited by the presently used taxonomic criteria.

The following curators and directors have kindly loaned type specimens and other valuable collections: Dr. Sten Ahlner (Naturhistoriska Riksmuseet, Stockholm), Dr. Reino Alava (Botanical Institute, Turku), Dr. Ove Almborn (Botanical Museum, Lund), Dr. Y. Asahina (Research Institute for Natural Resources, Tokyo), Dr. Charles Baehni (Conservatoire et Jardin Botaniques, Geneva), M. P. Bourrelly (Muséum National d'Histoire Naturelle, Paris), E. H. Bryan (Bernice P. Bishop Museum, Honolulu), Dr. A. Burkart (Instituto de Botánico Darwinion, San Isidro), M. Choisy (Lyon), M. Skytte Christiansen (Botanical Museum, Copenhagen), Dr. G. Cufodontis (University of Vienna, Vienna), Dr. W. L. Culberson (Duke University, Durham), Dr. H. des Abbayes (Université de Rennes, Rennes), Dr. Henry Imshaug (Michigan State University, East Lansing), Mr. Peter James (British Museum, London), Dr. A. Kostermanns (Herbarium Bogoriense, Bogor), Dr. I. M. Lamb (Farlow Herbarium, Cambridge), Dr. R. A. Maas Geesteranus (Rijksherbarium, Leiden), Dr. P. J. Greenway (The East African Herbarium, Nairobi), Dr. J. Millar (Chicago Natural History Museum, Chicago), Dr. G. Moggi (Istituto Botanico, Firenze), Dr. E. Müller (Institut für Spezielle Botanik, Zürich), C. E. Palmar (Glasgow Art Gallery and Museums, Glasgow), Dr. J. Poelt (Botanische Staatssammlung, Munich), Dr. K. Rechinger (Naturhistorisches Museum, Vienna), Dr. C. Rizzini (Jardim Botanico, Rio de Janeiro), Dr. W. Robyns (Jardin Botanique, Bruxelles), Dr. C. Rogerson (New

York Botanical Garden, New York), Dr. H. Roivainen (Botanical Museum, Helsinki), Dr. Rolf Santesson (Institute for Systematic Botany, Uppsala), Dr. R. Shaffer (University of Michigan, Ann Arbor), Sir George Taylor (Royal Botanic Gardens, Kew), Dr. J. W. Thomson (University of Wisconsin, Madison), Dr. K. Verseghy (Museum of Natural History, Budapest), Dr. R. Vincenzo (Istituto Botanico, Rome), Dr. E. F. Warburg (Oxford University, Oxford), and Dr. R. Woodson (Missouri Botanical Garden, St. Louis). Dr. Ove Almborn kindly forwarded to me for study loans from the National Herbarium, Pretoria, and from the Botanical Department, Trondheim.

In addition Drs. G. Degelius, T. Seshadri, and D. D. Awasthi (abbreviated DEGEL, SESH, and AWAS, respectively, in the list of species) have loaned us their valuable private collections.

I have had profitable exchanges of information and unpublished data with Drs. H. des Abbayes and Y. Asahina. Dr. Syo Kurokawa has aided in the chemical testing of many collections. Dr. J. L. Ramaut has also carried out chemical investigations of some of the species and kindly communicated his results to me.

This work has been supported in part by a grant from the National Science Foundation. Fieldwork in southern United States was supported in part by grants previously received from the American Philosophical Society and the Society of Sigma Xi.

Historical Survey

Taxa properly assigned to subgenus *Amphigymnia* have been described by at least 54 different lichenologists. This effort, starting with Hudson in 1762, has resulted in some 350 names of various taxonomic rank, of which 83 are accepted in this monograph. Because of the scattering of efforts by so many lichenologists, detailed summaries of the contributions of each worker will not be attempted here, but the following overall survey may be helpful in understanding the development of the subgenus.

Before Acharius proposed the genus *Parmelia* in 1803, only two species now recognized as Amphigymnias had been described, *Lichen perforatus* Jacq. and *L. perlatus* Huds. Between 1803 and the beginning of Nylander's work in 1860, the most important workers were Sprengel, E. Fries, Eschweiler, Fée, Taylor, Hepp, and Montagne. During this period of early explorations about 10 new species now recognized as valid were described.

From about 1860 to 1900 there was a period of intense activity by Nylander, Müller-Argau, Krempelhuber, Stirton, Tuckerman, Laurer, and others, during which more than 120 new names were created. Of these, about 30 are still accepted as valid. Müller and Nylander,

the giants of this period, were complete opposites in methods and species concepts. Nylander perfected color tests and had a narrow refined species concept. Of the 30 names in *Amphigymnia* that he proposed, 15 are still valid, a very low percentage of synonymy indeed. Müller, on the other hand, did not use chemistry and had a distressingly broad species concept. He described many varieties and forms, none of which are presently recognized. Of the 45 taxa he proposed, in fact, only six are accepted in this monograph. Krempelhuber made some very valuable investigations of the South American Parmelias which were largely overlooked by later workers. Stirton described a number of exotic species. Contributions by Tuckerman, Laurer, and others, were much smaller but nevertheless significant. Nearly all of the publications in this period were in the form of short floristic notes.

From about 1900 to 1930 another group of lichenologists carried on the impetus of the previous period. The most active workers were Vainio, Zahlbruckner, Hue, Lynge, Du Rietz, Steiner, Harmand, Bouly de Lesdain, Choisy, and Cengio-Samba. Vainio on the whole was a careful worker, proposing 26 names, of which 12 are valid species. His specimens, however, are notoriously scrappy, although well preserved. Zahlbruckner proposed 27 names in *Amphigymnia*, of which only 6 are accepted here. Lynge wrote the most valuable tropical flora, based on the rich Regnell collections from Brazil (cf. Hale, 1960). He proposed 22 names, of which 3 are acceptable. Hue was a prolific worker, describing some 23 taxa from tropical areas, 6 of them good species. Altogether, from the late 1890's to about 1930, somewhat over 100 new names were proposed and about 30 of these are accepted in this monograph. The floristic lists by these workers tend to be more comprehensive than those published before 1900, but fragmentary floristic notes still predominated.

The period since 1930 has marked the beginning of a modern synthesis of *Parmelia* on a worldwide scale and full acceptance of the International Code of Botanical Nomenclature. Major floristic works have been published by des Abbayes (1958, 1961) for Madagascar and western Africa and by Dodge (1953, 1959) for eastern and South Africa. There have been comprehensive floristic treatments of the European species (Hillmann, 1934; Maas Geesteranus, 1947; Tavares, 1945) and of the Japanese species (Asahina, 1952). The North American species were studied by Berry (1941). In the absence of a world monograph, however, many of the new species described since 1930 have only increased the already overburdened synonymy. Of nearly 100 taxa proposed in this period, only some 15 are accepted in this monograph.

Nomenclature

Lichenologists have been slow to appreciate the importance of nomenclature. Even now that the International Code has been universally accepted, some lichenologists are still publishing new species without designating holotypes and making new combinations without citing the basionyms. The concept of absolute priority regardless of rank was strong among older workers and has not yet completely died. This general lack of precision has resulted in endless confusion in floristic lists and the faithful perpetuation of serious errors in identification.

All too many of the older lichenologists failed to designate holotypes but listed two or more syntype specimens, leaving to later workers the important task of selecting lectotypes. Fortunately this practice is no longer permissible under the Code. The type method is based strongly on priority, and admittedly it becomes difficult to apply when holotypes are lost, unavailable for loan, or too fragmentary for recognition. The use of descriptions alone to characterize lichens has proved to be far less reliable than in other groups of cryptogams. When a type is unavailable, we have two choices, to ignore the name and list it as a nomen inquirendum or to select a neotype.

Neotypes are definitely problematic in lichenology because original descriptions are often wholly inadequate and illustrations are rarely made. Fortunately, we have as a sound precedent the careful work of Santesson (1952), who proposed a number of neotypes for the foliicolous lichens. Neotypes at their best are indispensable sources for the stabilization of names. In *Parmelia* and many other genera they are particularly valuable in establishing the chemical components of the type of the species. At their worst, neotypes are merely new species in disguise. The Code does not require a taxonomist to create neotypes merely because untypifiable names exist. If creation of a neotype deliberately displaces a later typifiable name, I believe it should be made with great hesitation. It has been necessary in subgenus *Amphigymnia* to select three neotypes, those for *P. subcrinita* Nyl., *P. sulphurata* Nees & Flot., and *P. perforata* (Jacq.) Ach. All other species or varieties without type specimens are ignored for the present (see list of nomina inquirenda on p. 343).

Mention should be made here on the recognition of synonyms. The mere listing of a name as a synonym has too often been taken as prima facie evidence of identity. In reality, judgment of synonymy is often a personal decision that parallels a lichenologist's species concept. For

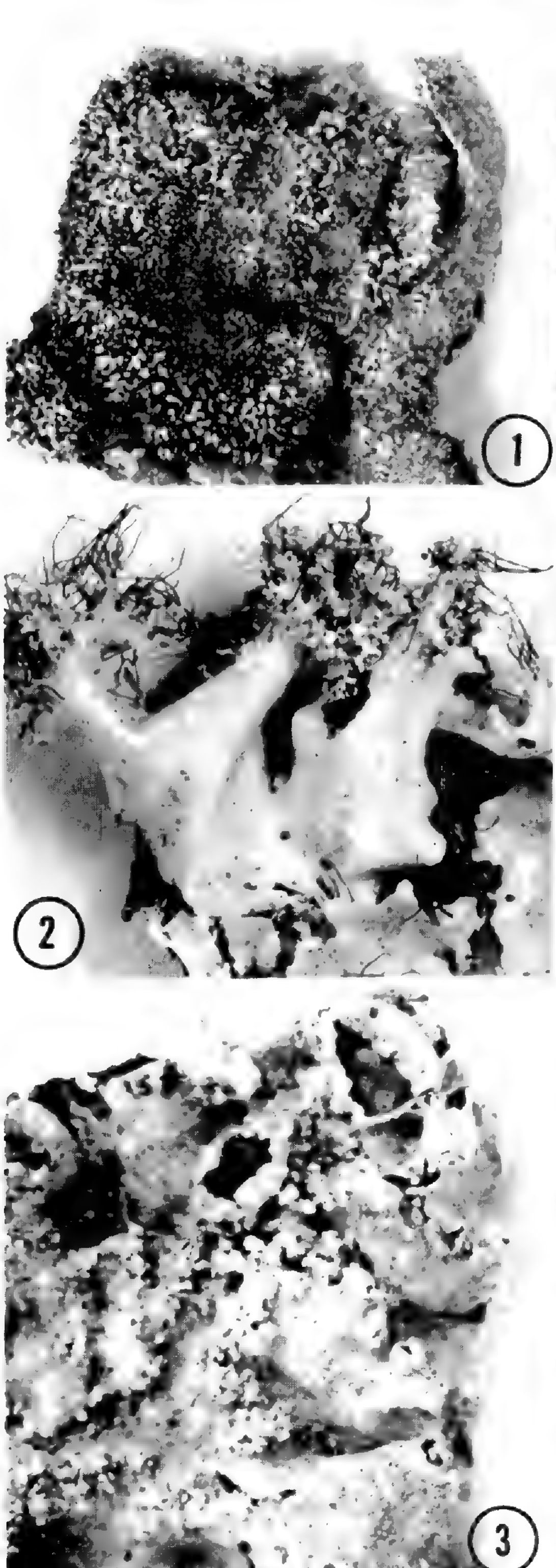
example, Müller-Argau had an extremely broad species concept, and when he made studies of the important tropical species described by Fée, Eschweiler, and Taylor, he reduced many names to synonymy. These were listed as synonyms by Zahlbruckner in his Catalogus Lichenum Universalis and have been so considered without further study by succeeding lichenologists. Actually, although many of these names represent valid species, they have been effectively lost in the literature, and progress in tropical lichen study has been held back because of this.

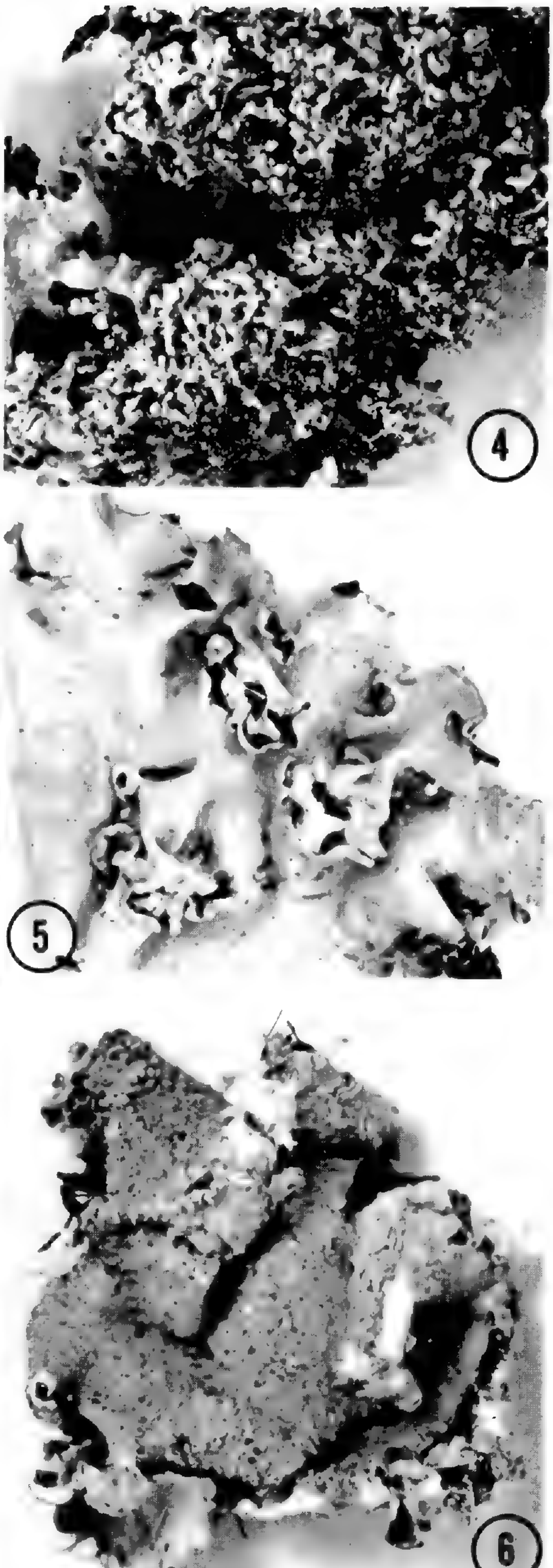
A listing of synonymy in this monograph indicates as nearly absolute identity in morphology and chemistry as is possible to determine with the methods at hand. We have tended therefore to follow a relatively narrow species concept. It is a simple matter for other lichenologists to combine names they feel are synonyms, but at least until more adequate field collections are available, many of them must stand as distinct species. It seems probable that a much finer species concept will prevail in 50 years, with greater emphasis on now unrecognized or unappreciated morphological and chemical characters.

Morphological Characters

Parmelia subgenus *Amphigymnia* is fortunately rich in distinct and easily recognized taxonomic characters. However, there has been no general agreement as to the value and importance of these characters nor have lichenologists consistently reported them with equal clarity when describing species. Descriptions in the literature run the gamut from Zahlbruckner's exhaustive, though not always pertinent, full-page descriptions to Gyelnik's or Nylander's one sentence statements. Asahina (1952) is one of the few lichenologists who has categorically listed the fundamental species characters for *Parmelia*. These are, in his opinion, cilia, soredia, isidia, spore size, pseudocyphellae and maculae, and chemical components.

Neither Asahina nor other lichenologists have tried to justify their selection of various morphological characters. It is assumed that most are based on taxonomic intuition, a notoriously variable factor. Obviously the most easily recognized traits, cilia, soredia, and isidia, are first selected as species characters, and the more subtle, less easily recognized traits are either overlooked or given some rank according to each taxonomist's judgment. It would be advantageous to be able to evaluate each taxonomic character quantitatively so that some objective measure of its importance can be arrived at. For example, are soredia and isidia of comparable value as species characters? Do cilia on the margin of the amphithecium have any taxonomic value?





1. Isidia of *Parmelia crinita* Ach. (*Fink* 114, US). 2. Sorediate isidia of *P. mellissii* Dodge (*Imshaug* 14235, US). 3. Isidia of *P. pseudotinctorum* des Abb. (*des Abbayes*, US). 4. Coralloid isidiate outgrowths of *P. ramuscula* Hale (holotype, BM). 5. Marginal soredia of *P. cristifera* Tayl. (*Hale* 20073, US). 6. Pustules of *P. rimulosa* Dodge (*Almborn* 1897, LD). All photographs enlarged ×4.

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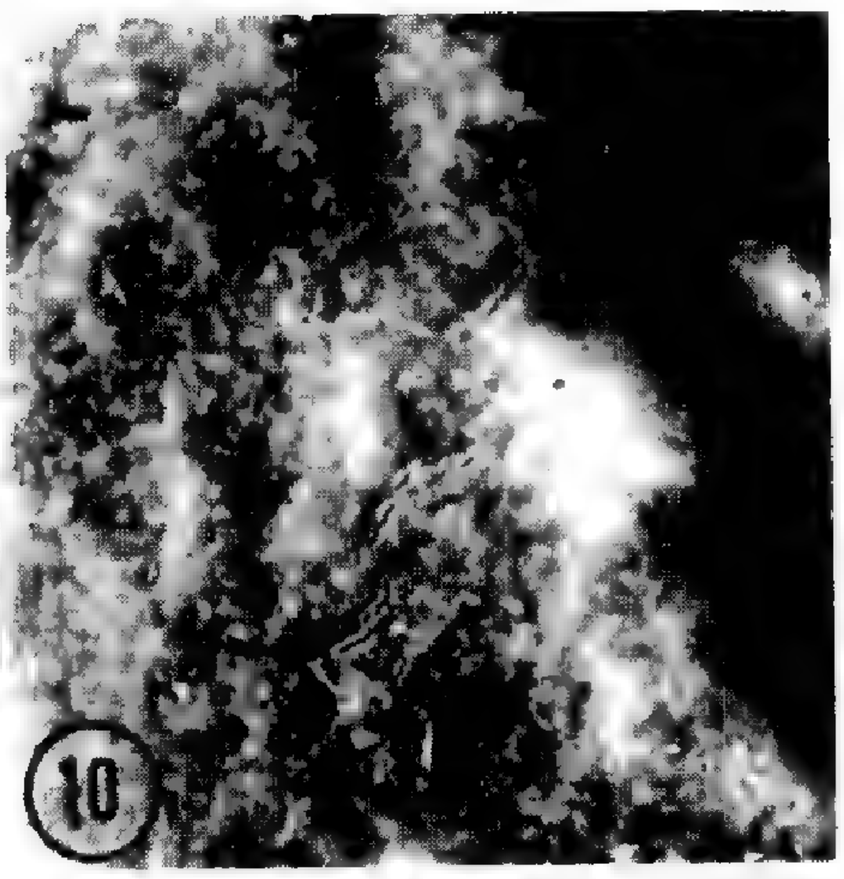

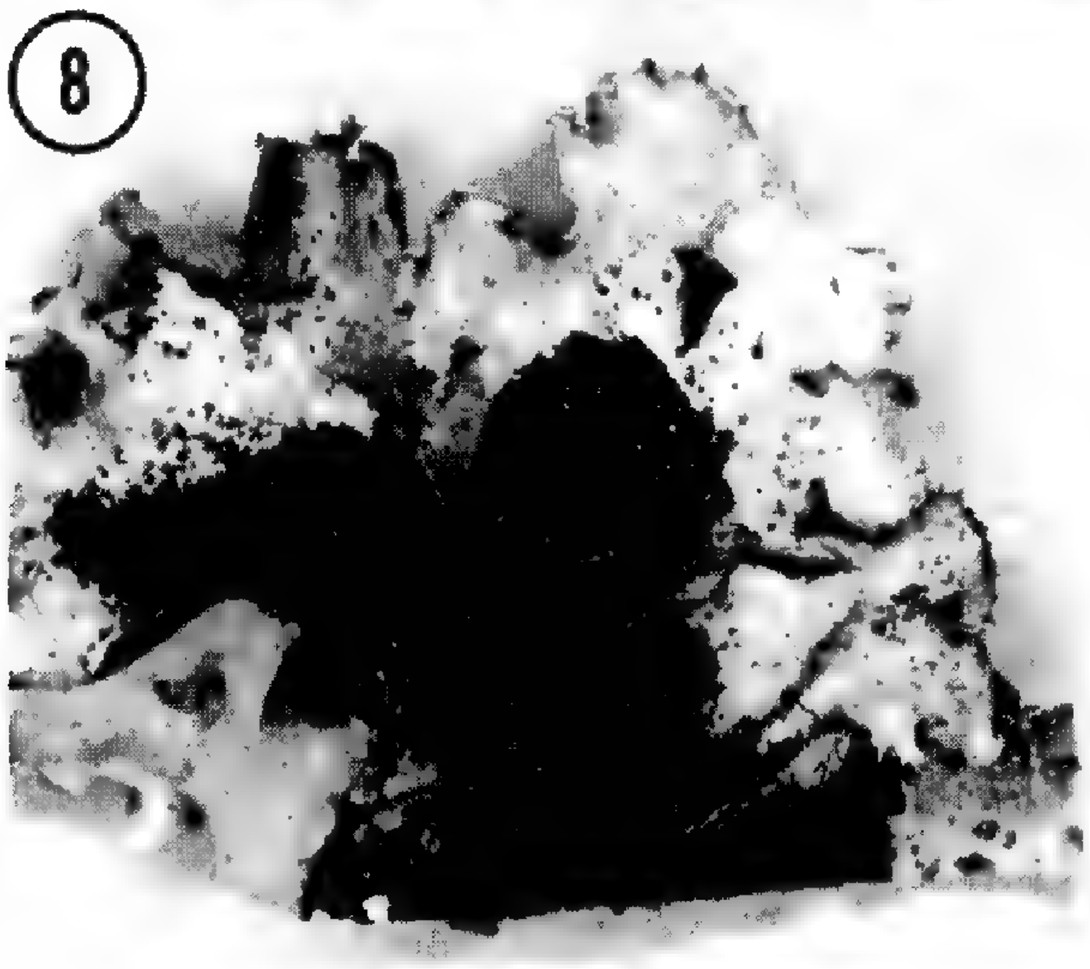

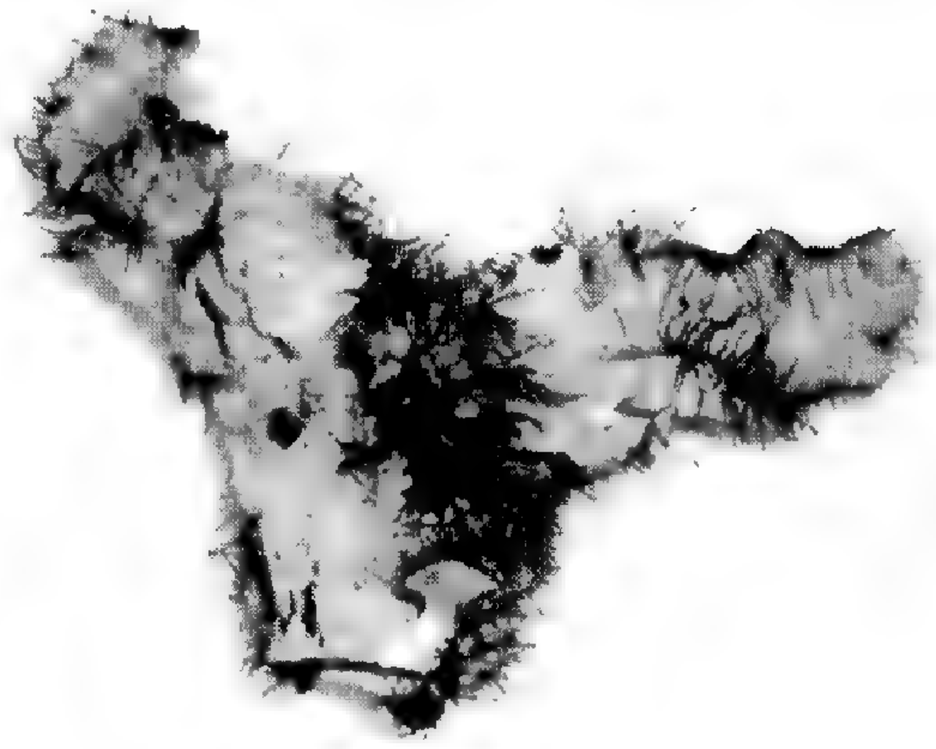

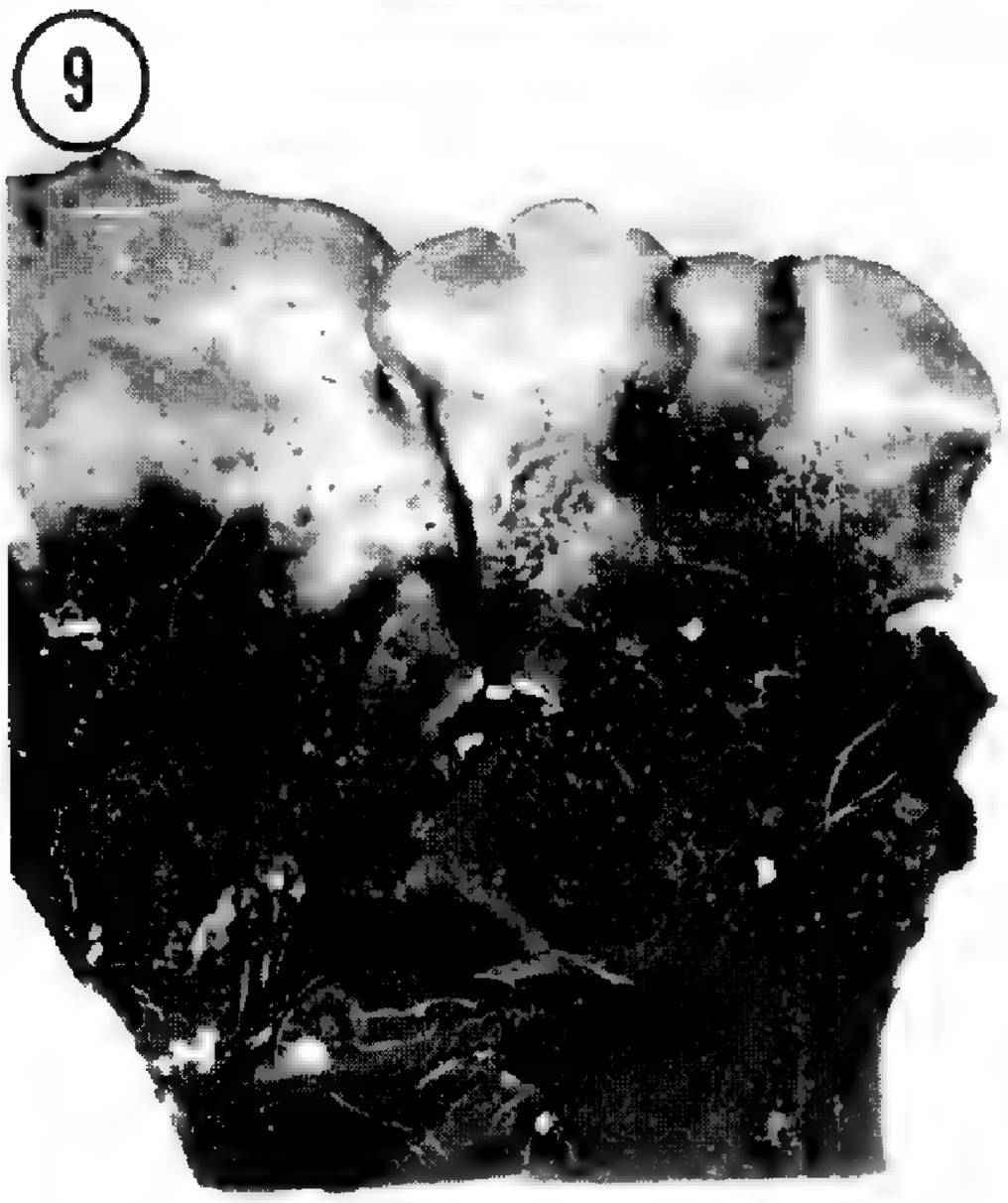

7. Apothecia of *Parmelia hanningtoniana* Müll. Arg. (*Degelius*, Feb. 16, 1960, US) (×1). 8. Lower side of *P. perforata* (Jacq.) Ach. (*Hale* 21737, US) (×2). 9. Lower side of *P. tinctorum* Nyl. (*Hale* 17068, US) (×2). 10. Maculae on the upper cortex of *P. perforata* (Jacq.) Ach. (×5). 11. *P. wainii* A. L. Sm. showing marginal cilia (isotype, US) (×1) 12. Lower side of *P. subtinctoria* Zahlbr. (*Hale* 16649, US) (×2).

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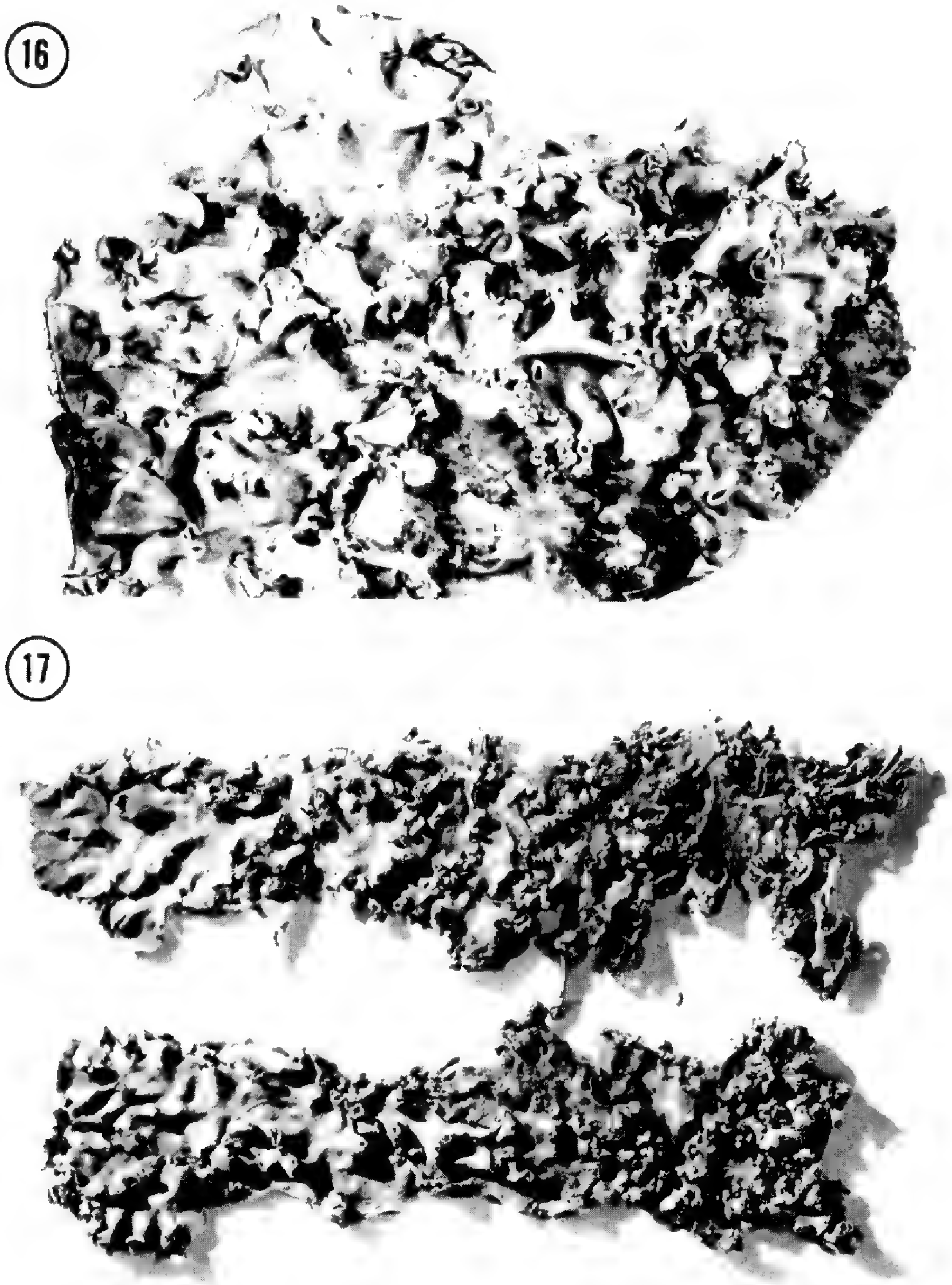
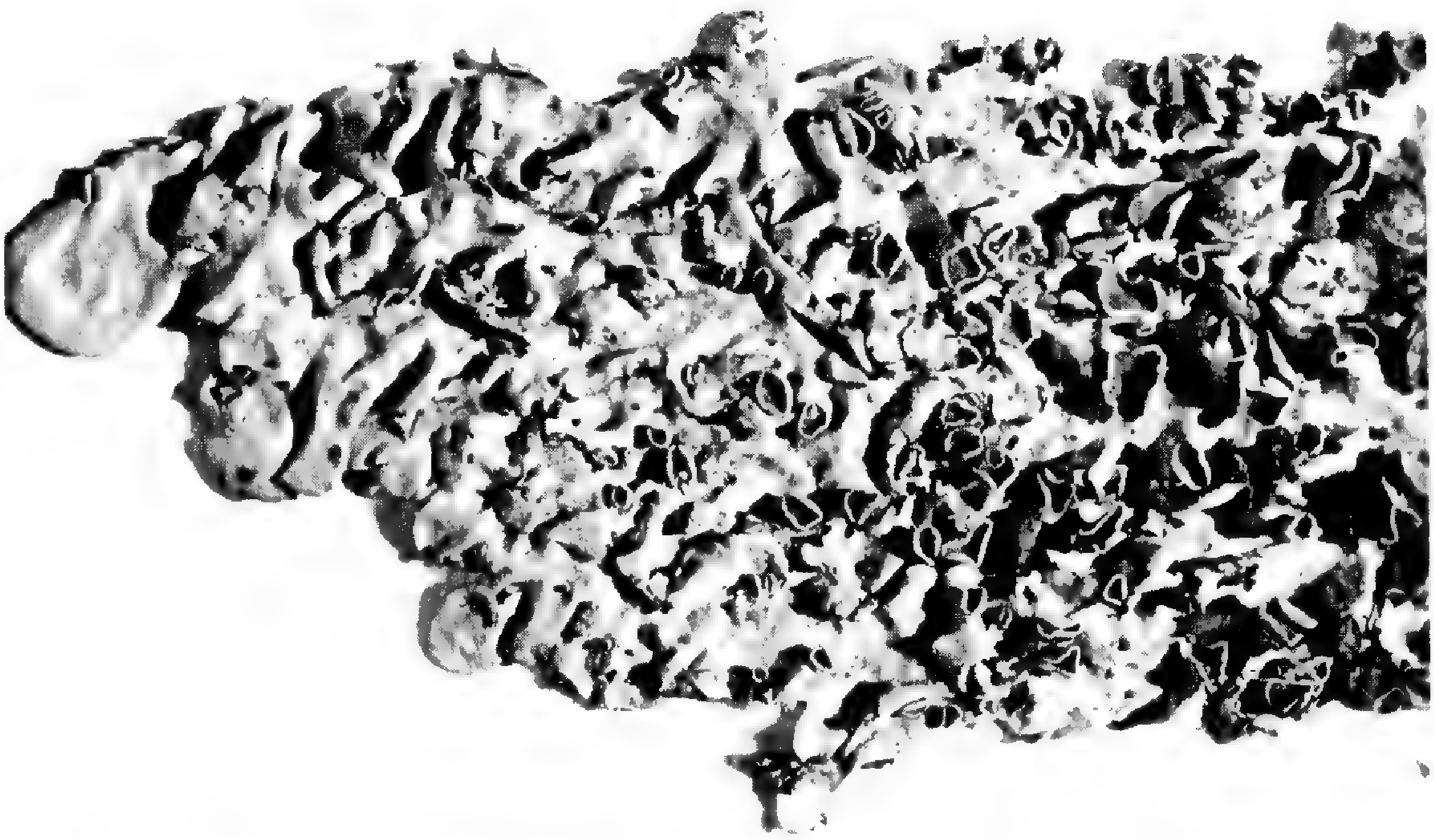
13. *Parmelia eborina* Hale (isotype, US). 14. *P. dominicana* Vain. (*Allard* 15958, US).
15. *P. myelochroa* Hale (holotype, US). All photographs ×1.

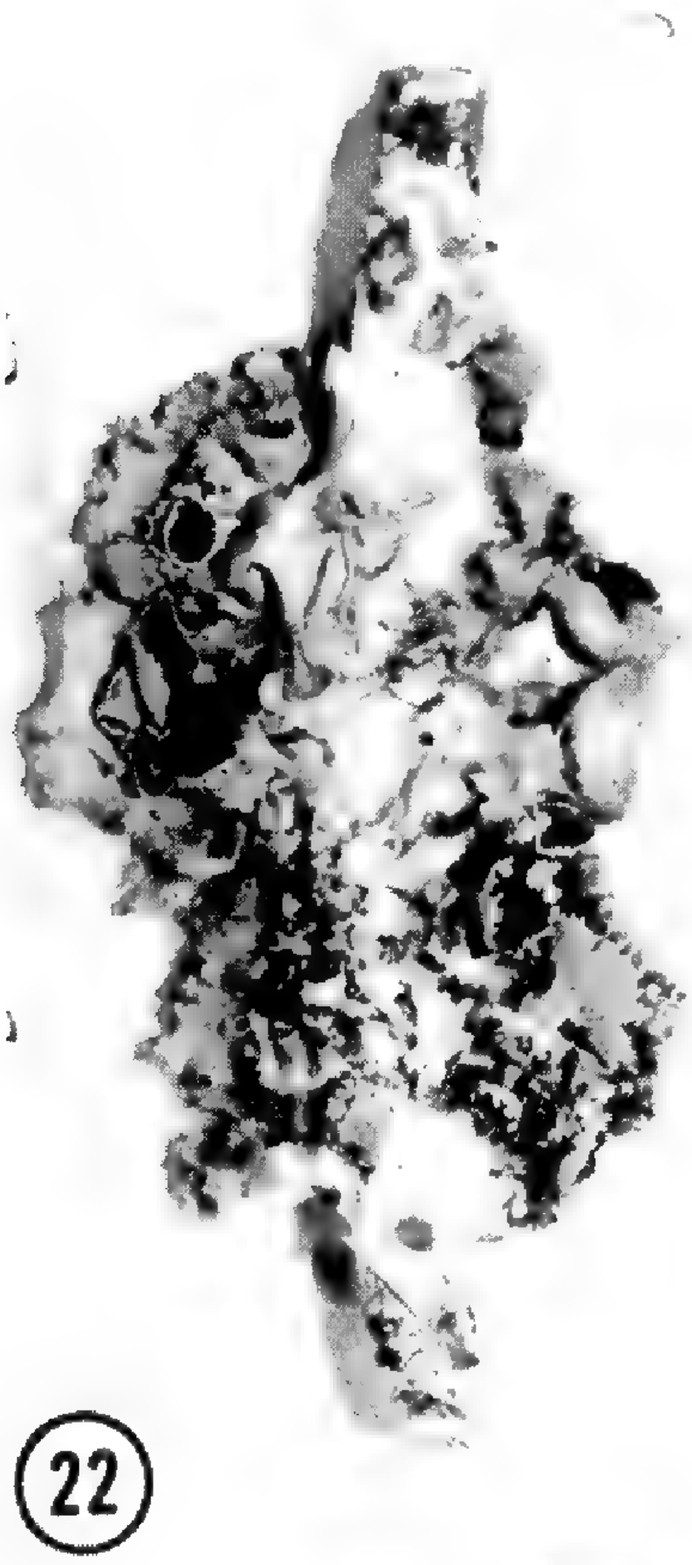


16. *Parmelia cristifera* Tayl. (*Ogata* s.n., US). 17. *P. rubifaciens* Hale (holotype, US). Both photographs ×1.

18. *Parmelia peralbida* Hale (holotype, FH). 19. *P. praesorediosa* Nyl. (holotype, H). Both photographs ×1.



20. *Parmelia zollingeri* Hepp (holotype, L) (×1). 21. *P. flavotincta* Hale (isotype, US) (×2).



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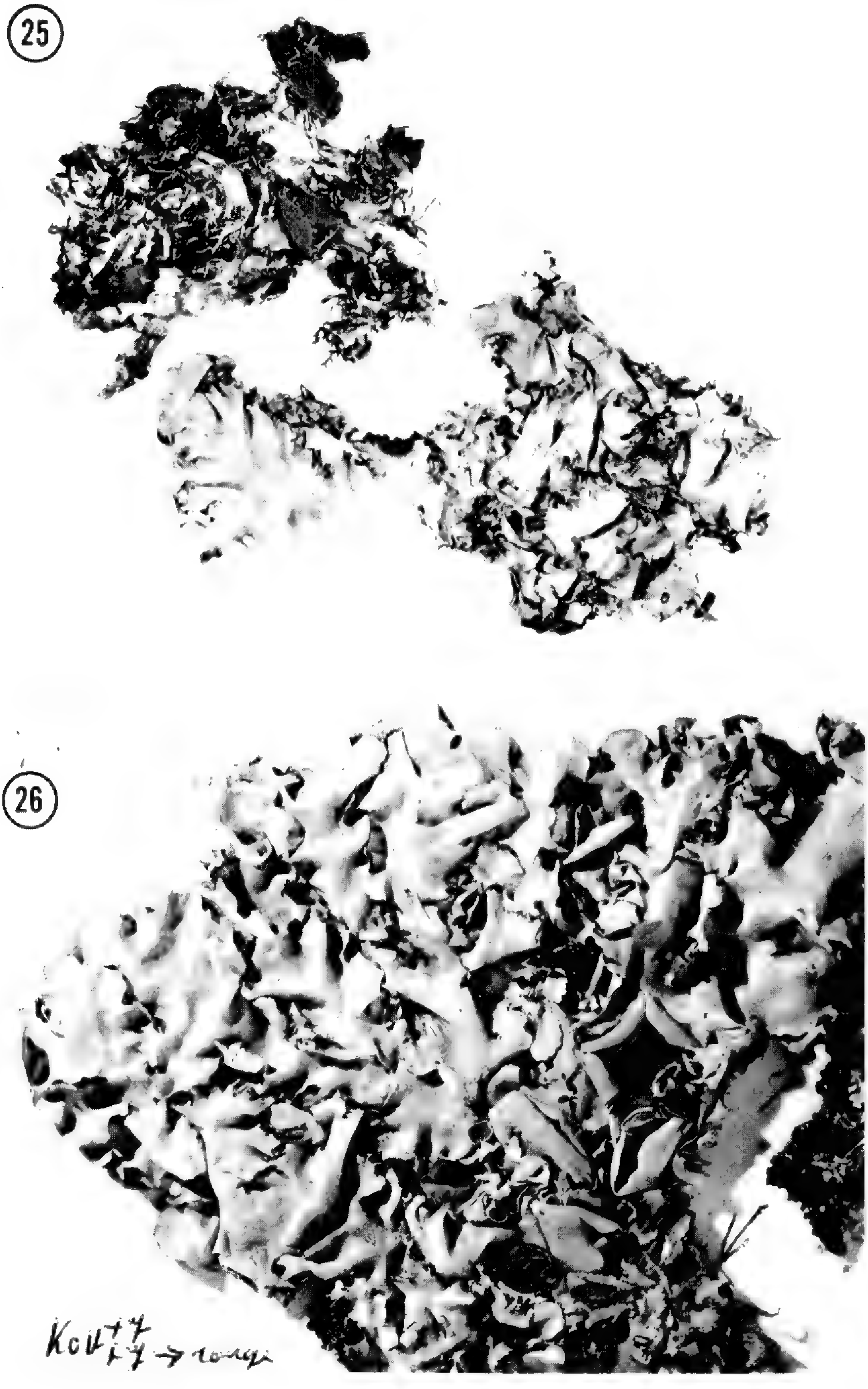
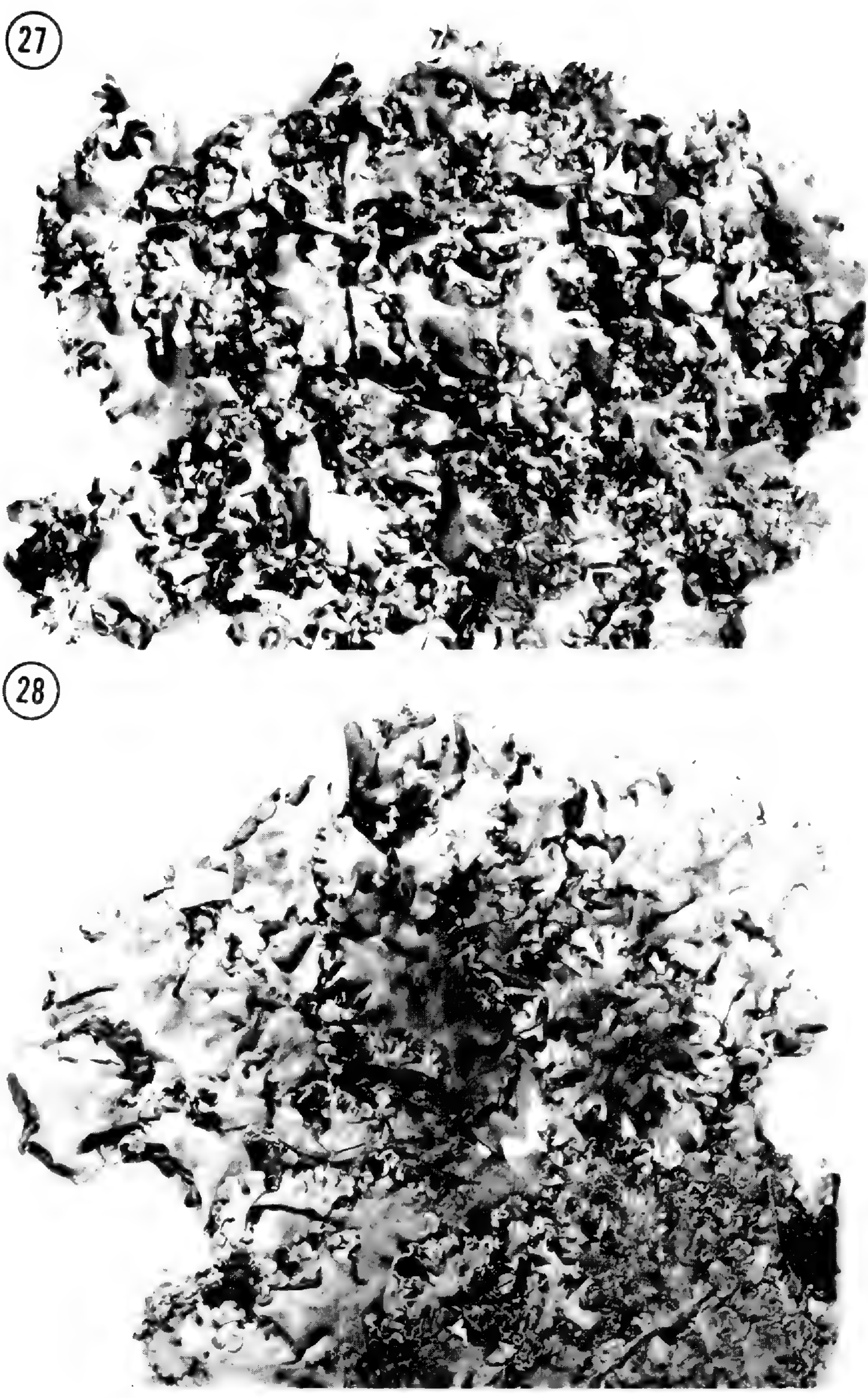
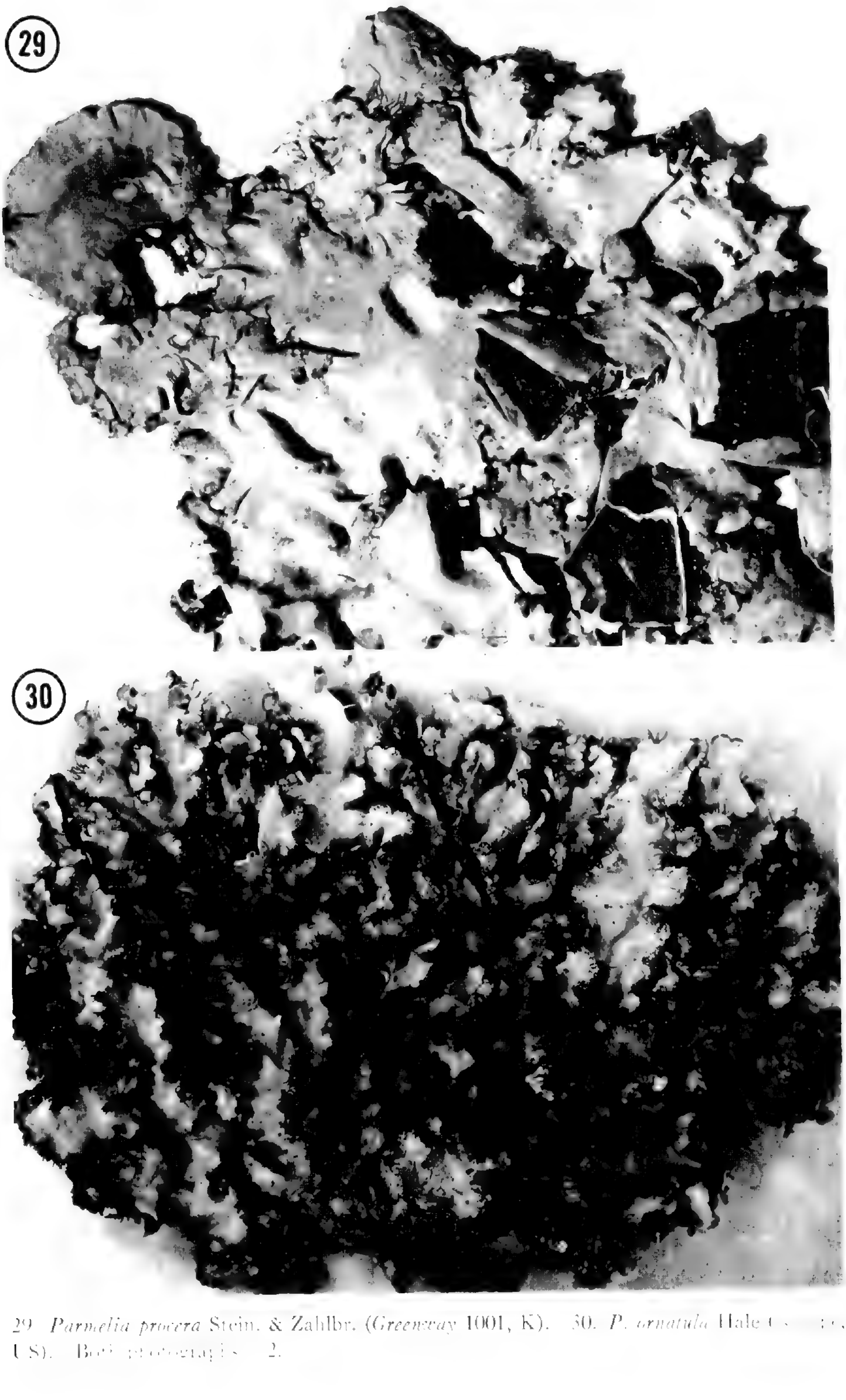
22. *Parmelia abnuens* Nyl. (lectotype, H). 23. *P. maclayana* Müll. Arg. (isotype, G).
24. *P. amboimensis* Dodge (*Gossweiler* 10008, US). All photographs ×1.



25. *Parmelia merrillii* Vain. (*Masuda* F456, TNS). 26. *P. eurysaca* Hue (holotype, P). Both photographs ×1.



27. *Parmelia margaritata* Hue (holotype, P). 28. *P. stuppea* Tayl. (*Maury* 3318, P). Both photographs ×1.



29. *Parmelia procera* Stein. & Zahlbr. (*Greenway* 1001, K). 30. *P. ornatula* Hale (holotype, US). Both photographs × 2.

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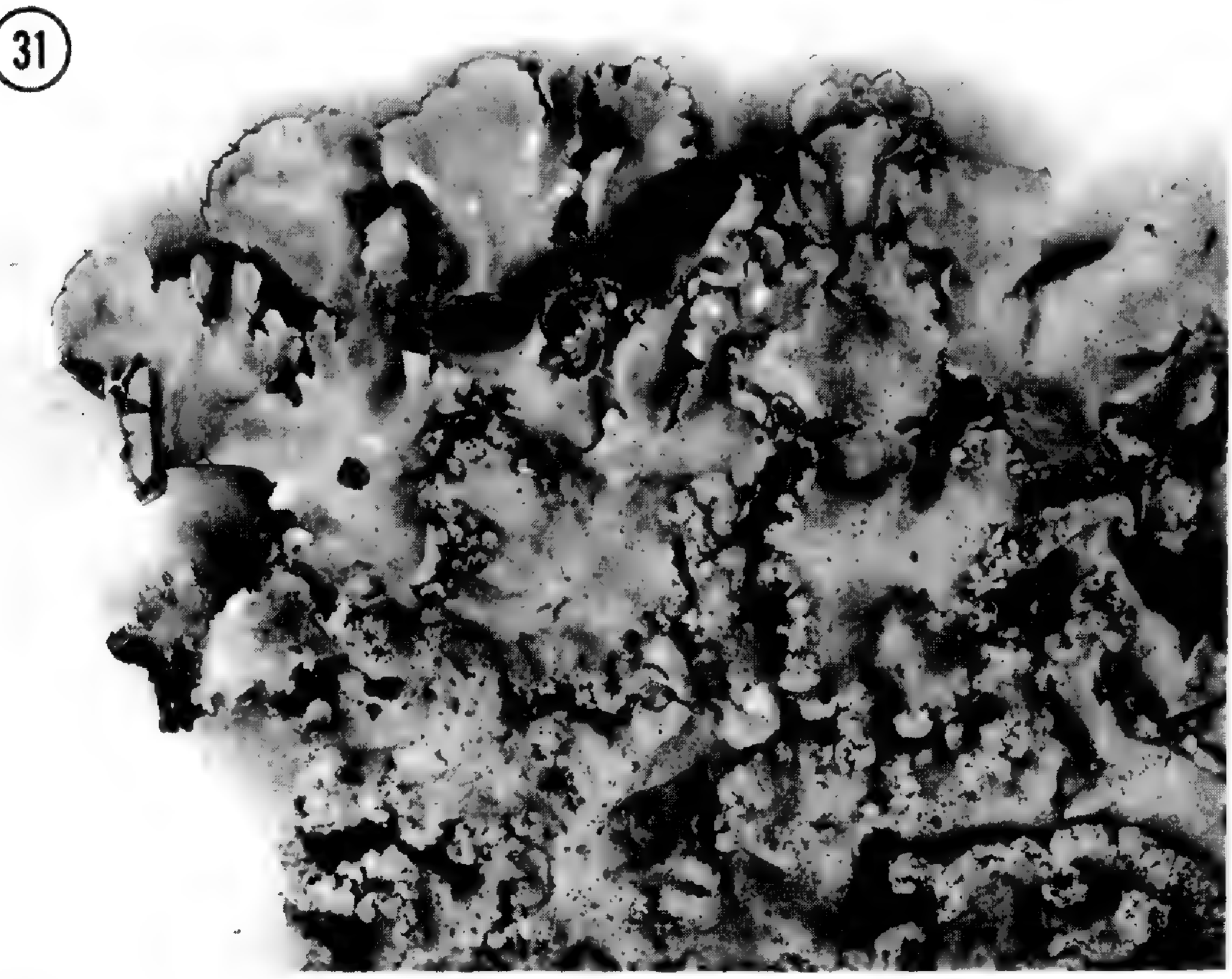

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31. *Parmelia miranda* Hale (holotype, US) (×2). 32. *P. flavescens* (Krempelh.) Nyl. (holotype, M) (×1).

33. *Parmelia subtinctoria* Zahlbr. (holotype, W). 34. *P. subsumpta* Nyl. (holotype, H). 35. *P. subcaperata* Krempelh. (*Glaziou* 1839, H). All photographs ×1.

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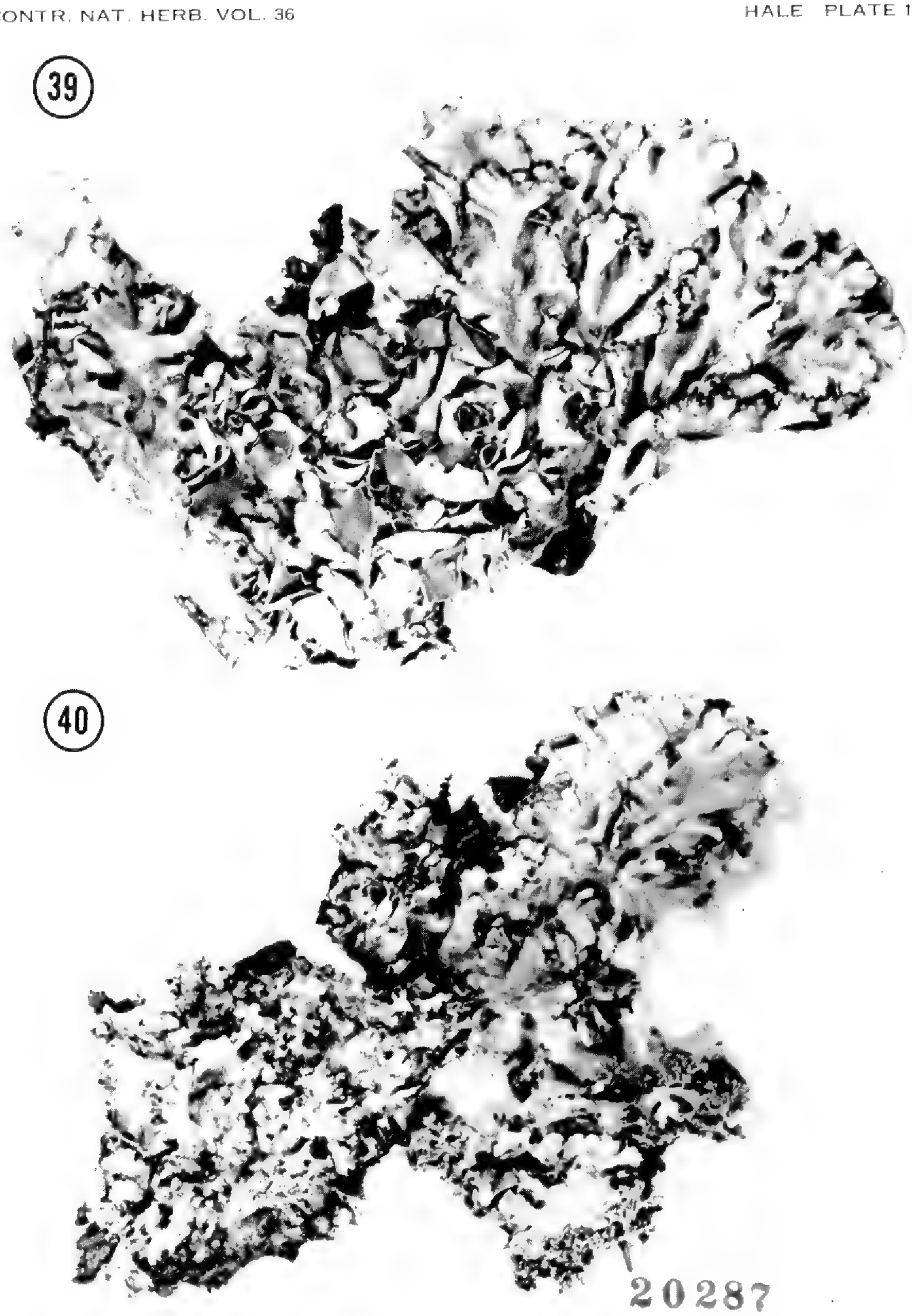
36. *Parmelia pseudonilgherrensis* Asah. (holotype, TNS). 37. *P. diacidula* Hale (holotype, LD). 38. *P. cooperi* Stein. & Zahlbr. (holotype, W). All photographs ×1.



39. *Parmelia reparata* Stirt. (*Hale* 19406, US). 40. *P. coralliformis* Hale (holotype, US). Both photographs ×1.

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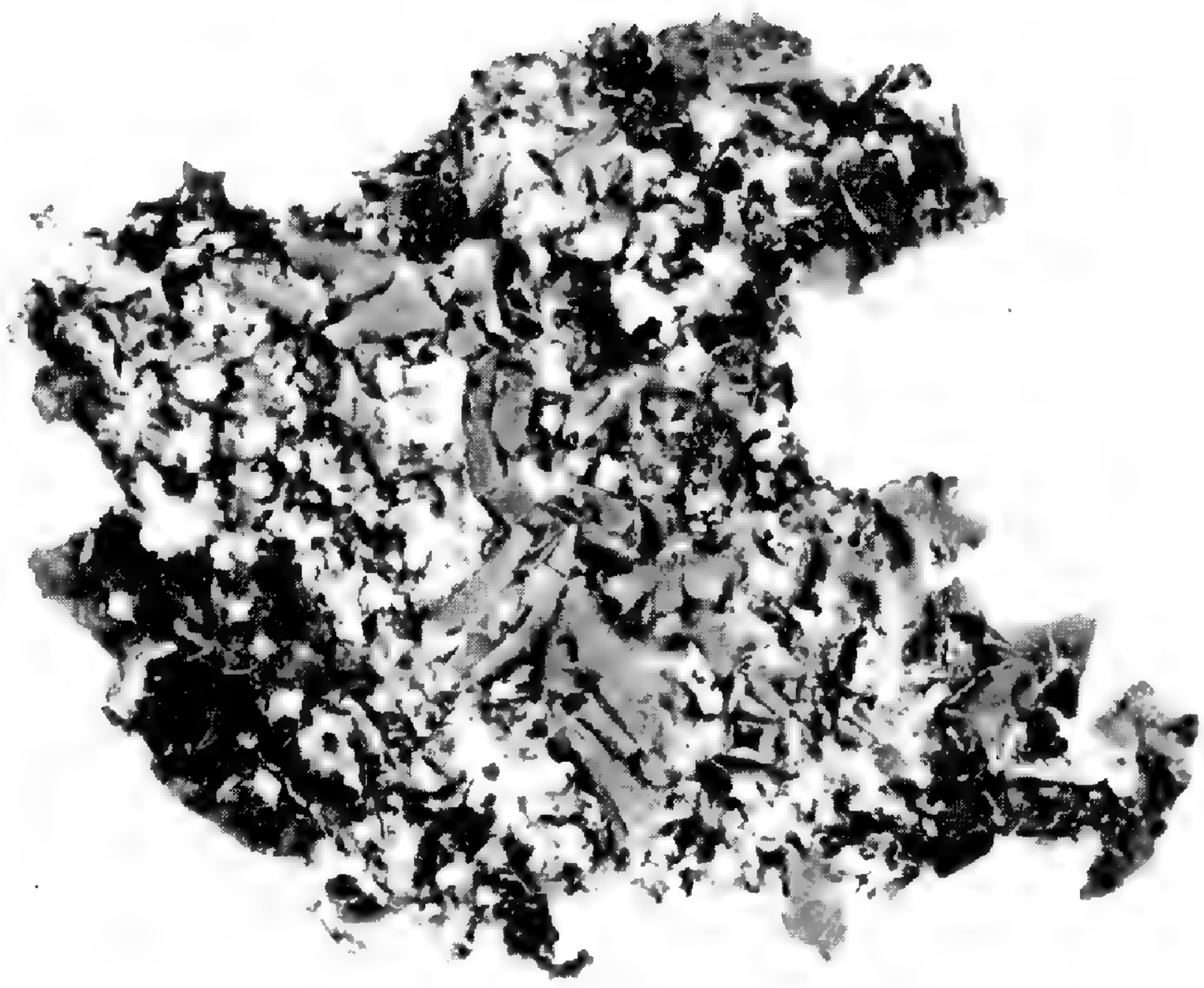

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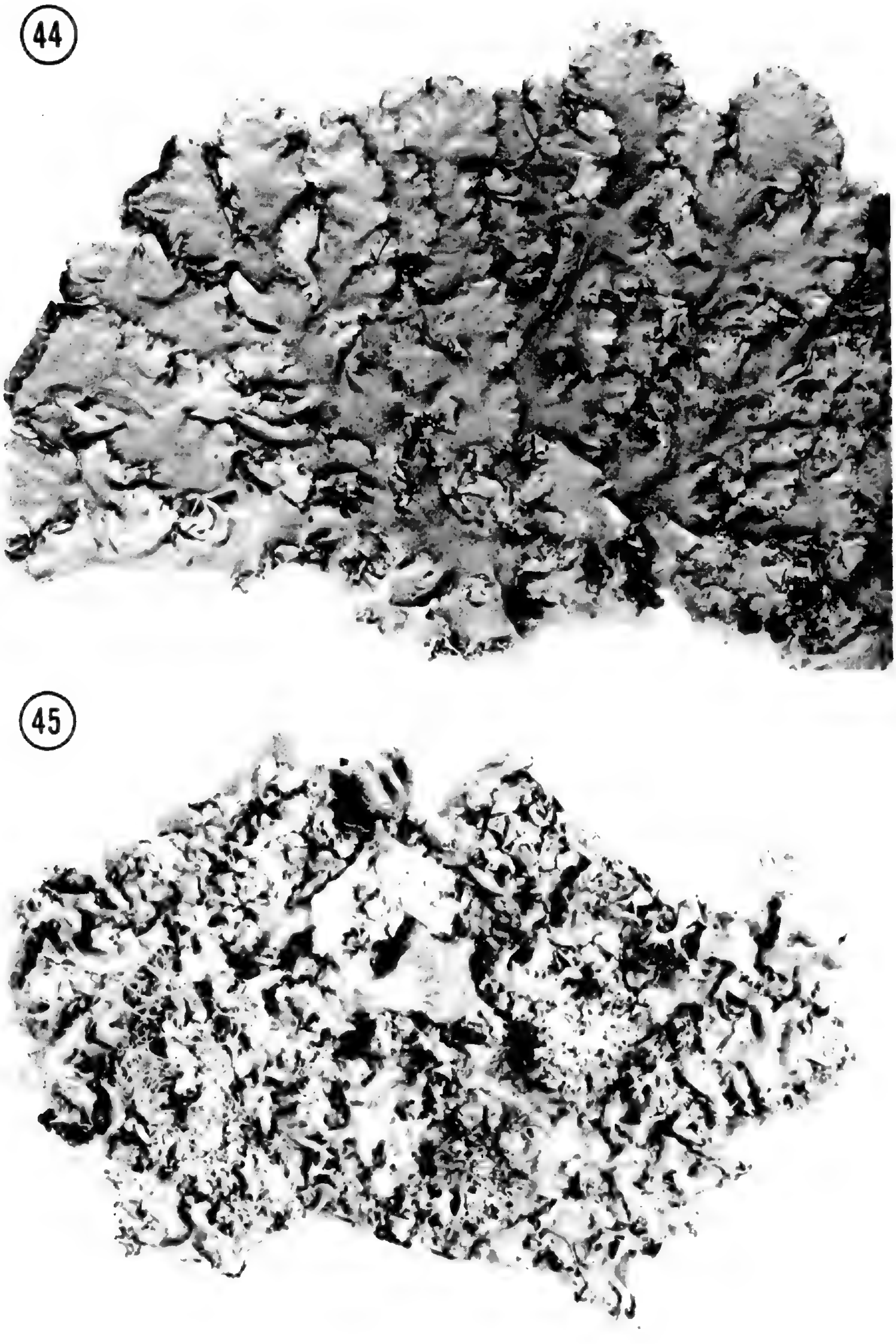
41. *Parmelia chiapensis* Hale (isotype, US). 42. *P. hababiana* Gyel. (lectotype, G). 43. *P. argentina* Krempih. (isotype, US). All photographs ×1.



44. *Parmelia leucosemotheta* Hue (holotype, P). 45. *P. subrugata* Krempih. (holotype, M). Both photographs ×1.

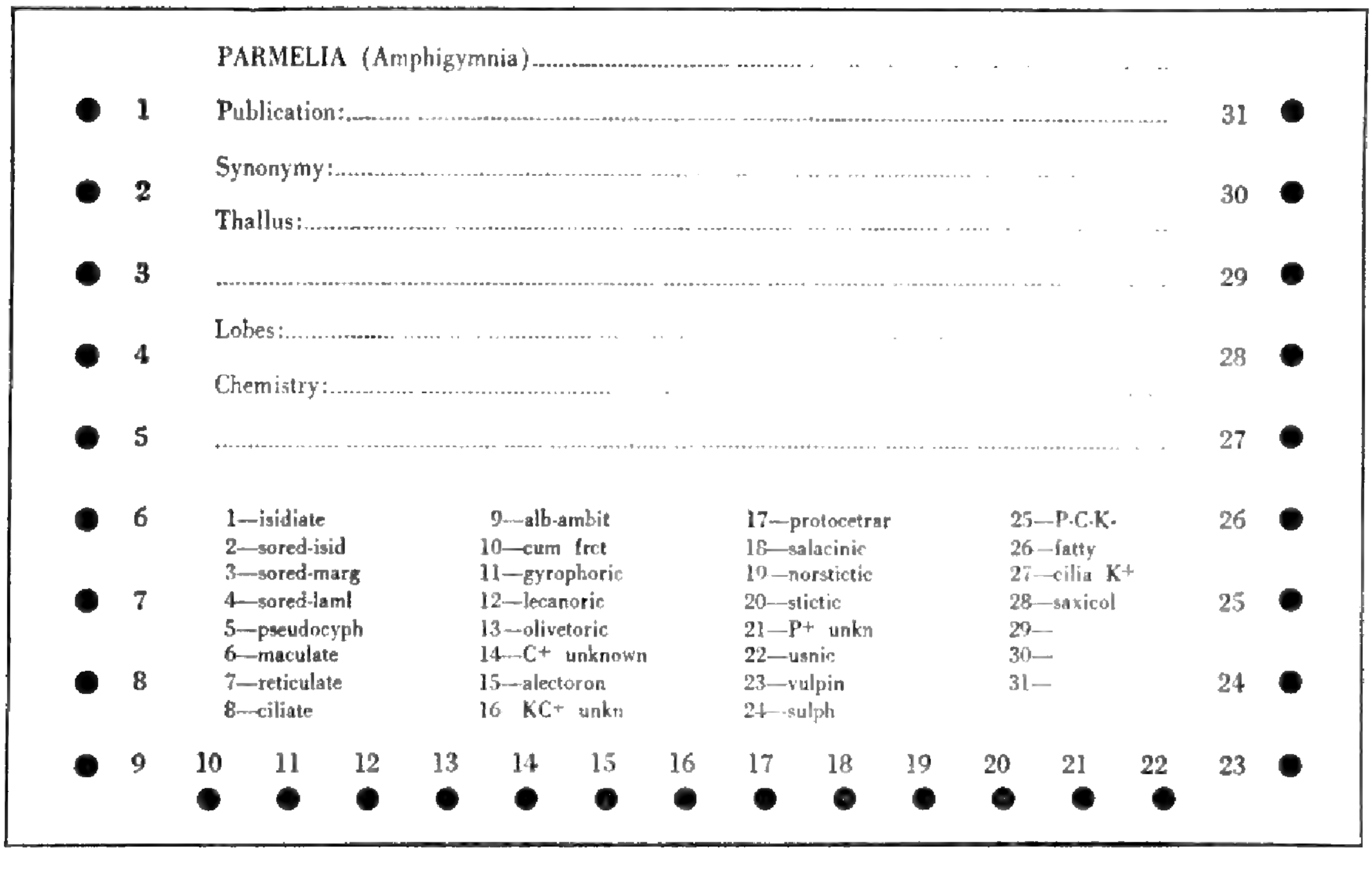


FIGURE 1.—Marginal punch card (5×8 inches) used to record data for each species.

Because we have had available data on all known species of *Amphigymnia*, we have taken this opportunity to present below not only descriptions of the major characters but also their frequency and degree of association with each other, in order to evaluate their relative taxonomic importance. The data for each species were reproduced on marginal punch cards (fig. 1) to facilitate rapid calculation of frequencies and association. All data were derived first from the type specimen and supplemented by studies of herbarium specimens compared with types.

ISIDIA AND SOREDIA

Isidia are one of the major characters useful at the species level. They occur in 25 of the 106 species of *Amphigymnia*. There is considerable variation in the structure and development of isidia. Sixteen species have normal cylindrical isidia, ranging from simple to more or less branched with a diameter of 0.04–0.10 mm. (pl. 1). These isidia may be short-ciliate in robust specimens of *P. aberrans*, *P. crinita*, *P. pseudocrinita*, *P. subcrinita*, and *P. xanthina*. The isidia of *P. pseudotinctorum* are exceptionally large and thickened, up to 0.3 mm. in diameter (pl. 1). In *P. mellissii*, *P. paulensis*, and *P. subcorallina*, the isidia are in part granular or sorediate, but always recognizable as isidia (pl. 1). In *P. lophogena* and *P. setchellii* the isidia are irregularly thickened and at length pustular, without developing soredia. These latter structures are classified as isidia here only as a matter of convenience; they may represent a structure quite distinct from isidia. The most peculiar isidia, if indeed they are

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isidia, are the coralloid outgrowths of *P. flavotincta*, *P. fasciculata*, *P. coralliformis*, and *P. ramuscula* (pl. 1). These are very large coralloid structures, produced laminally and marginally from small laciniae, which apically become irregularly thickened and at times pustulate or sorediate.

Soredia occur in 34 species. Soredia are much less variable than isidia and usually differ only in position on the thallus. The most typical position in *Amphigymnia* is strictly marginal in linear soralia, characteristic of 25 of the 34 species. Well-known examples are *P. austrosinensis*, *P. cristifera*, and *P. stuppea* (pl. 1; fig. 2). In older thalli marginal soralia may eventually cause the lobe margins to become involute. Two species, *P. hypomiltoides* and *P. natalensis*, have marginal as well as extensive laminal soralia, with laminal soralia predominating. Four species have soredia which originate submarginally; that is, the soredia originate just back from the thallus margin. The soralia may be linear and, advancing on a broad front, soon cause the lobes to become strongly revolute (fig. 2), as in *P. perlata* and *P. ochroglauca*. In *P. arnoldii* and *P. margaritata*, the soralia are mostly orbicular and originate on short marginal laciniae which also become revolute (fig. 2). *Parmelia bangii*, *P. crypotoxantha*, *P. fracta*, and *P. rimulosa* (pl. 1) have strictly laminal,

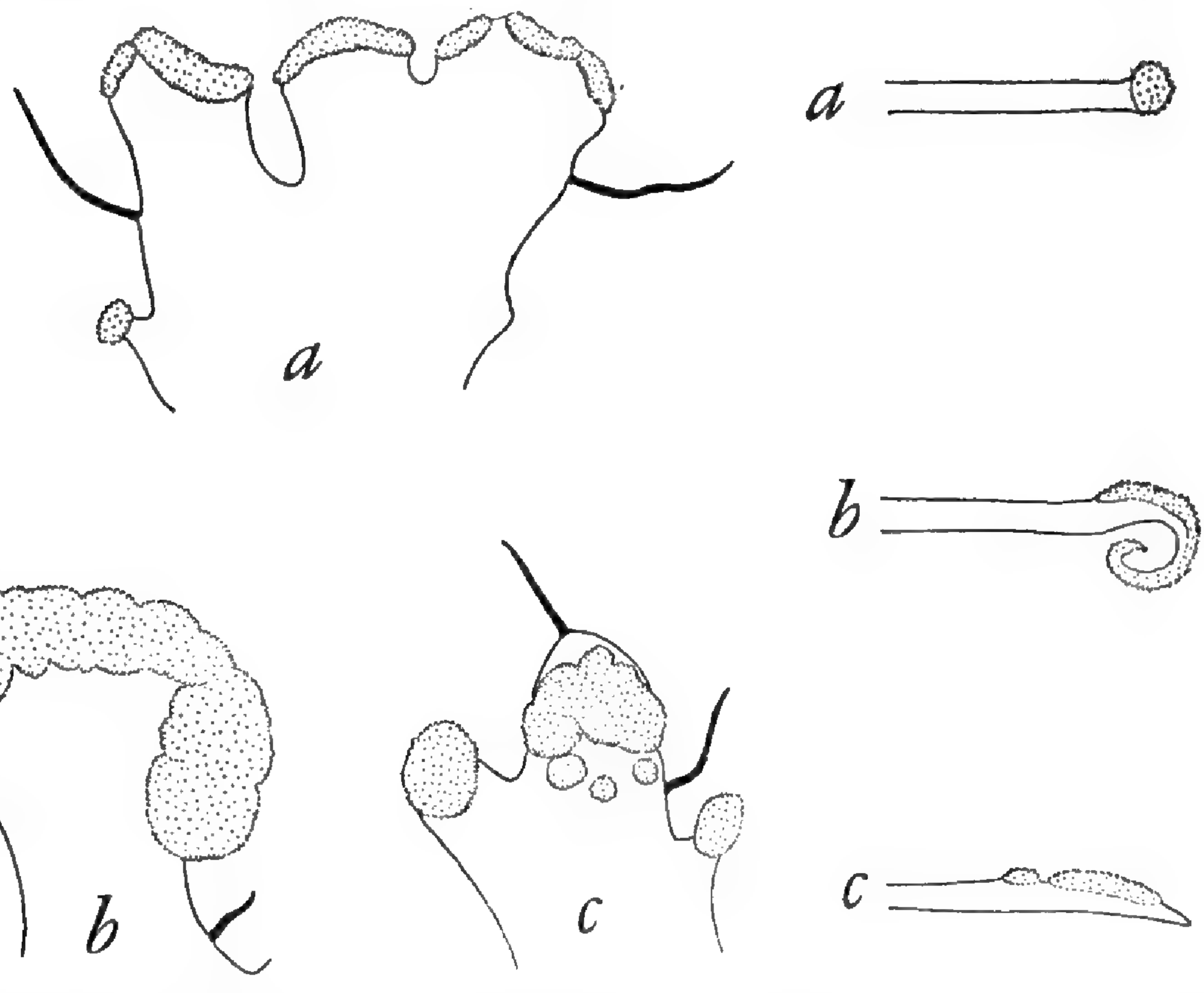


FIGURE 2a–c.—Soredial formation in *Amphigymnia: a*, *Parmelia stuppea* Tayl.; *b*, *P. perlata* (Huds.) Ach.; *c*, *P. margaritata* Hue.

irregular soralia which originate from cracks or pustules. These intergrade to a certain extent with sorediate or pustulate isidia but are probably best considered as a modification of soredia.

Plants which lack soredia or isidia comprise the remaining 47 species. These plants may have lobules or a rugose upper cortex, but they are always distinguishable from sorediate or isidiate plants.

The degree of association between isidia, soredia, and lack of soredia and isidia (abbreviated NIS) is shown in table 1. This table, as an example, shows that of the 25 isidiate species, 68% have cilia; that of the 34 sorediate species, 77% have cilia; and that of the 47 species lacking soredia or isidia, 72% have cilia. Such close percentages may be interpreted to mean that there is little significant association between soredia, isidia, and lack of soredia and isidia.

TABLE 1.—*Percentage of isidiate, sorediate, and nonsorediate-nonisidiate (NIS) species with each of 16 different traits.*

Trait (Number of species)	Isidiate (25)	Sorediate (34)	NIS (47)
gyrophoric acid	12	12	4
lecanoric acid	8	9	6
alectoronic acid	8	21	26
cryptochlorophaeic acid	4	3	4
protocetraric acid	28	15	13
salacinic acid	16	18	13
norstictic acid	0	6	6
stictic acid	8	3	2
usnic acid	20	15	2
maculae	12	27	38
cilia	68	77	72
white rim below	0	9	15
perforate disc	6	30	43
small spores	53	55	47
intermediate spores	24	30	26
large spores	24	15	26

It is noteworthy that in the case of alectoronic acid, protocetraric acid, maculae, white rim below, and perforate apothecia, the sorediate–NIS species have similar percentages of association, in each case more or less obviously different from the isidiate species. There is only one example, usnic acid, where isidiate and sorediate plants share a similar percentage of association measurably different from that of NIS plants and no outstanding example for isidiate–NIS. These observations suggest that sorediate–NIS species are closely, perhaps genetically, related and that isidiate plants belong to an entirely different lineage. There is good grounds then for believing that isidia are good species characters and that two otherwise identical plants differing chiefly in the presence or absence of isidia are separate species.

Further confirmation of the distinctness of isidia can be gained by taking the isidiate species one by one and searching among the nonisidiate species for "counterparts," species which seem to be identical in every character except for the absence of isidia. Obviously some degree of personal judgment is called for in this selection, but on the whole we have used the narrowest possible interpretation of identity. For example, there are 2 isidiate species which have both sorediate and NIS counterparts.

Isidiate	Sorediate	NIS
P. endosulphurea	*P. araucariarum*	*P. myelochroa*
P. subtinctoria	*P. subsumpta*	*P. subcaperata*

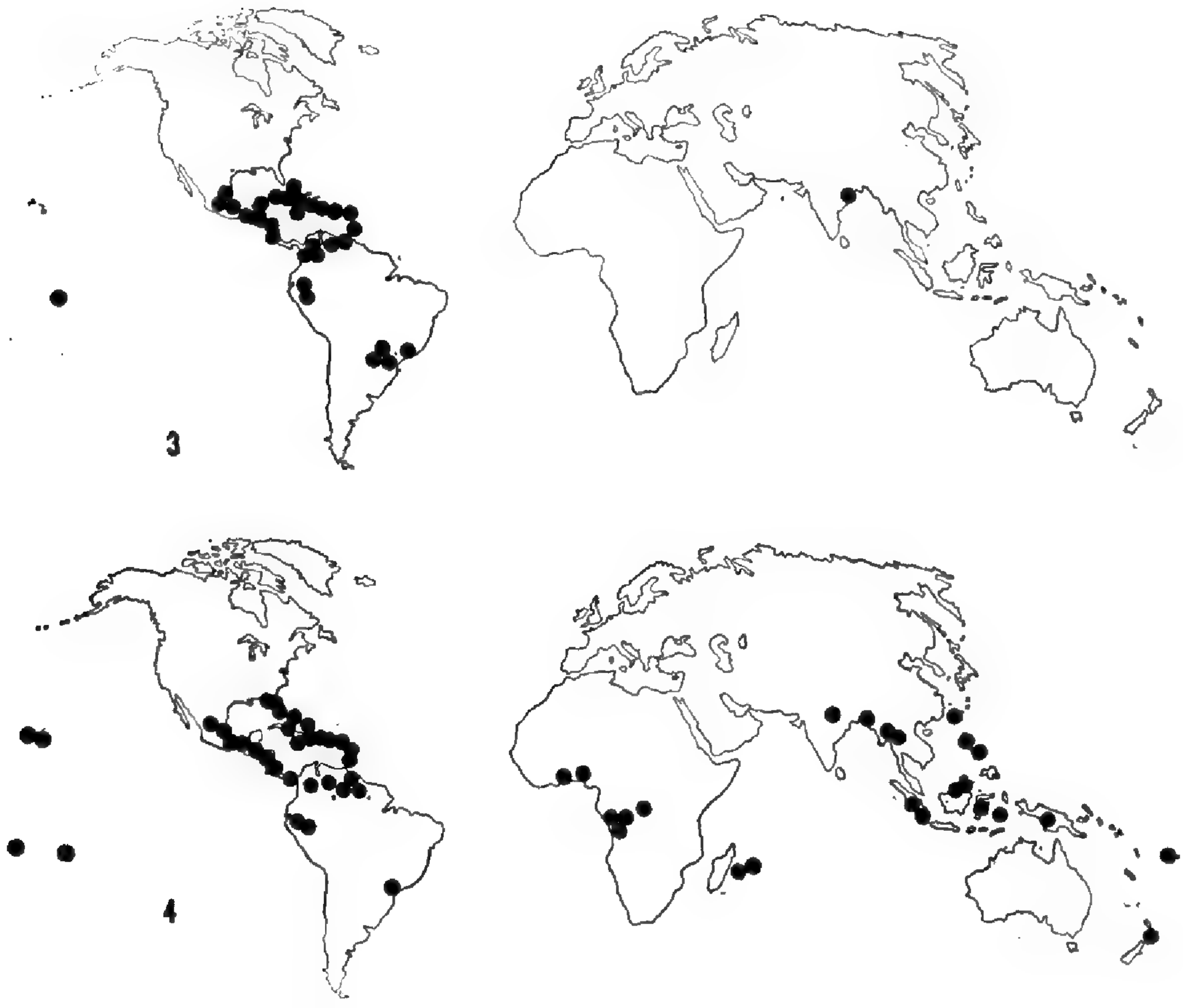
Two species appear to have sorediate counterparts only: *P. crinita–P. perlata*, and *P. erasmia–P. hypomiltoides*. There is only one isidiate species with an apparent NIS counterpart: *P. paulensis–P. melanothrix*. The remaining 20 isidiate species have no obvious counterparts. Most species pairs that look promising are found to differ in spore size, perforation of apothecia, or other characters.

If we proceed now to a similar analysis of sorediate species, we find many species with counterpart nonsorediate species, as follows:

Sorediate	Nonsorediate
P. cristifera	*P. latissima*
P. dilatata	*P. zollingeri*
P. austrosinensis	*P. andina*
P. cooperi	*P. hololoba*
P. hypotropa	*P. perforata*
P. hababiana	*P. abessinica*
P. reparata	*P. leucosemotheta*
P. pseudonilgherrensis	*P. nilgherrensis*
P. praesorediosa	*P. mesotropa*
P. defecta	*P. soyauxii*

Combining these with previously mentioned cases, about 14 of the total 34 sorediate species are counterparts of nonsorediate species. This comparison, along with the frequency data (table 1) already mentioned, suggests that presence of soredia is a significantly weaker species character than isidia. We may be dealing simply with species that may or may not produce soredia or produce them only rarely or under special conditions.

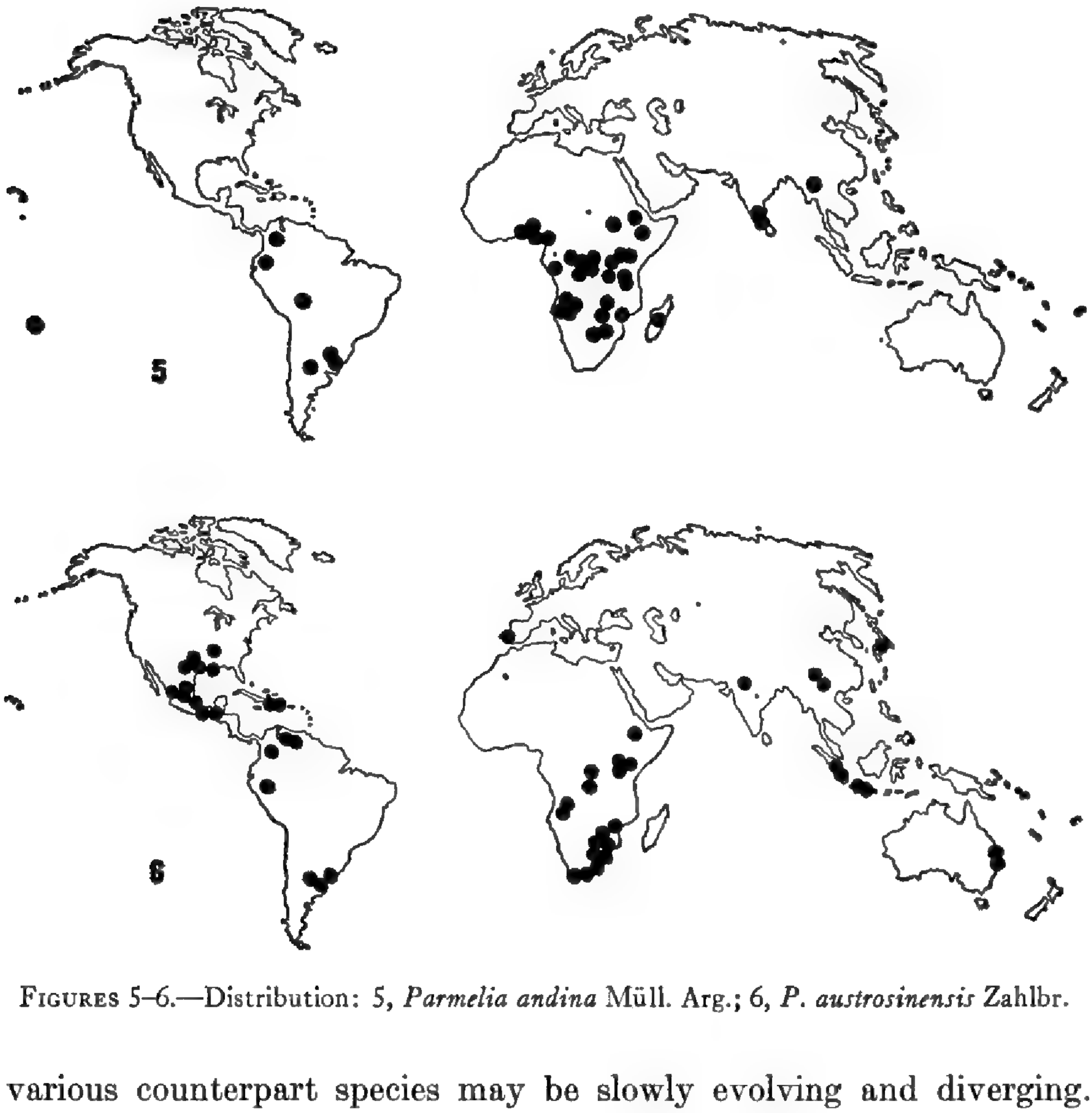
On the whole, however, counterpart sorediate species have a more northerly range (or in the Southern Hemisphere more southerly) than the nonsorediate species. For example, *P. latissima* (fig. 3) is strictly tropical in distribution. It is common in Cuba but does not occur in southern Florida, only 140 km. distant. On the other hand, the sorediate counterpart, *P. cristifera*, has a much broader distribution; it occurs not only in Cuba but also as far north as South



FIGURES 3–4.—Distribution: 3, *Parmelia latissima* Fée; 4, *P. cristifera* Tayl.

Carolina and Georgia in the United States (fig. 4). In South Africa *P. andina* is almost completely lacking south of the Tropic of Capricorn (fig. 5), whereas sorediate *P. austrosinensis* is extremely common on both sides of this line (fig. 6). Furthermore, *P. andina* is completely absent in North America and Mexico. *Parmelia hypotropa* (fig. 8) has a more northerly center of distribution in the United States than the nonsorediate counterpart *P. perforata* (fig. 7).

The existence of counterpart species may have some significance in interpreting speciation in *Amphigymnia*. The ancestral species were probably isidiate or nonsorediate. At the present time almost all nonsorediate species are confined to tropical regions and many of them are restricted to one continent. By contrast half of the pantropical species are sorediate. In some of the species, e.g., *P. latissima*, perfect sorediate counterparts (*P. cristifera*) have developed, and most of them are much more widely distributed in temperate areas than the nonsorediate counterpart. However, in some cases, such as *P. diacidula*, *P. direagens*, *P. grayana*, *P. rubifaciens*, *P. sancti-angelii*, and *P. subarnoldii*, no nonsorediate ancestral forms have survived, if indeed they ever existed. Finally, these

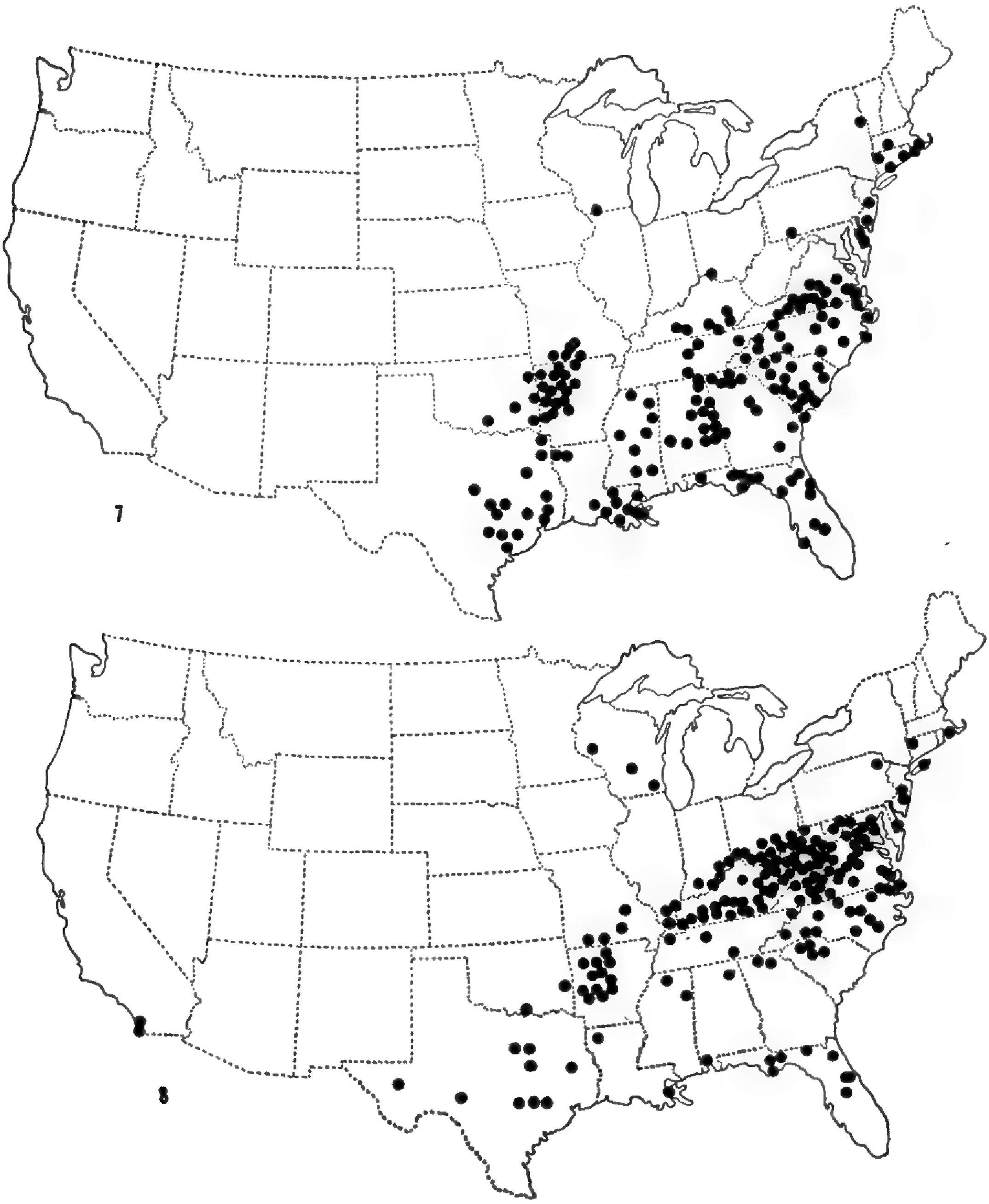


FIGURES 5–6.—Distribution: 5, *Parmelia andina* Müll. Arg.; 6, *P. austrosinensis* Zahlbr.

various counterpart species may be slowly evolving and diverging. For example, *P. tinctorum* would be a perfect isidiate counterpart to *P. andina* and *P. austrosinensis* if it were maculate and had perforate apothecia. *Parmelia eurysaca* would be a logical counterpart of sorediate *P. stuppea*, except that it has distinct laciniae. Many other examples could be cited.

CILIA

Cilia are very common in *Amphigymnia*, occurring in 77 of the 106 species, sporadically produced in the axils of the lobes in *P. zollingeri*, *P. dilatata*, and *P. conformata*, and entirely lacking in the remaining 26 species. The longest cilia, such as those of *P. cooperi*, *P. rampoddensis*, or *P. wainii*, are up to 6 mm. long and very conspicuous (pl. 2). At the other extreme, the cilia of *P. perlata* may be quite sparse and not more than 1 mm. long. The cilia of *P. argentina* and *P. mellissii* sometimes react K+ purple, but we do not believe that this reaction has any taxonomic value.



FIGURES 7–8.—Distribution in the United States: 7, *Parmelia perforata* (Jacq.) Ach.; 8, *P. hypotropa* Nyl.

The degree of association of cilia with other morphological and chemical characters is shown in table 2. This table shows, for example, that of the 77 ciliate species, 3% have lecanoric acid and of the 29 nonciliate species, 21% have lecanoric acid. Cilia have a positive or negative association with more than half of the characters listed. We believe that this high degree of correlation indicates that cilia are important taxonomic characters. This hypothesis is strengthened by the fact that there are almost no counterpart ciliate-

nonciliate species. The only clear-cut examples are *P. hololoba* and *P. andina*. It is impossible to find exact counterparts for the other 76 ciliate species among the 29 nonciliate species.

TABLE 2.—*Percentage of species with or without maculae, cilia, or perforate disc having various traits.*

Trait	Percentage of species having Maculae		Cilia		Perforate disc	
	Present	Absent	Present	Absent	Present	Absent
(Number of species)	(30)	(76)	(77)	(29)	(27)	(56)
gyrophoric acid	10	8	12	0	4	5
lecanoric acid	10	7	3	21	18	4
alectoronic acid	22	18	26	3	30	16
cryptochlorophaeic acid	10	0	4	0	7	3
protocetraric acid	3	21	10	31	0	23
salacinic acid	22	13	18	10	22	14
norstictic acid	10	3	4	14	11	2
stictic acid	0	5	5	0	0	7
usnic acid	0	12	12	7	0	14
maculae	—	—	35	10	59	20
cilia	90	66	—	—	82	68
white rim below	37	0	12	7	26	7
perforate disc	59	21	37	24	—	—
small spores	63	45	57	35	74	39
intermediate spores	26	27	18	43	22	28
large spores	11	29	25	22	4	33

MACULAE

Maculae in *Amphigymnia* are more or less regular, submacroscopic white spots in the upper cortex (pl. 2). They are related to but should not be confused with the irregular effigurate pseudocyphellae in *P. saxatilis* (L.) Ach. or *P. sulcata* Tayl. or with typical pseudocyphellae. Maculae are not always easy to distinguish in *Amphigymnia* and have usually been overlooked by lichenologists. Some 27 species have distinct maculae, 3 have variable or questionable maculae, and 76 have a normal opaque cortex without maculae. Maculae occur, however, on the amphithecium and pedicels of nearly all species. In some of these the maculae may be distinct at the base of the pedicels but do not clearly go beyond this point on the thallus, as in *P. eciliata*.

Maculae are strongly positively or negatively associated with seven other characters (table 2). Of these characters, cryptochlorophaeic acid, protocetraric acid, white rim below, and perforate apothecia share a similar degree of association with cilia. Maculae would then seem to be good species characters, especially since there are no recognizable maculate-nonmaculate counterpart species.

LOWER SIDE

The lower side in *Amphigymnia* is more variable than usually thought. Typically most species are jet black, with rather long, unbranched, moderate to sparse rhizines. The outer rim is naked, shiny, dark brown or less commonly mottled tan or brown and ivory (pl. 2). About 91 of the species in this monograph can be classified in this group.

A second group also has a black rhizinate center, but the marginal area is entirely pale, ivory to white, and conspicuously set off from the black center (pl. 2). There are at least 11 species with this so-called white rim:

P. abessinica
P. argentina
P. euneta
P. hababiana
P. hypotropa
P. melanothrix
P. paulensis
P. perforata
P. rigida
P. subrugata
P. uruguensis

It will be noted from table 2 that a white rim is highly associated with maculae, perforate apothecia, and cilia, and seems to be a sound character.

A third type of lower side found in three species is characterized by very short, rather dense rhizines produced to or nearly to the margin (pl. 2). The lower cortex is entirely pale brown or brown or blackened toward the center with age. These species (*P. subcaperata*, *P. subsumpta*, and *P. subtinctoria*) also have a strongly maculate cortex, cilia, and salacinic or cryptochlorophaeic acid. There are no counterpart species with a black lower side. The species could be placed in subgenus *Parmelia*, but because of their large broad lobes and lack of reticulation they are more properly treated here.

APOTHECIAL CHARACTERS

The typical apothecium is more or less distinctly pedicellate and has a rugose, maculate amphithecium. In *P. hanningtoniana* the amphithecium is very coarsely rugose to lobulate (pl. 2). The exciple is most frequently entire, but in *P. abessinica*, *P. abnuens*, *P. argentina*, *P. corniculans*, *P. euneta*, *P. hanningtoniana*, *P. melanothrix*, *P. merrillii*, *P. ornatula*, *P. perforata*, *P. rigida*, *P. subrugata*, *P. uruguensis*, and *P. wainii*, the exciple is more or less dentate and frequently but not always ciliate. Cilia are not constant in any one species and appear to have no consistent value as a species character. The exciple is conspicuously laciniate in *P. appendiculata*, *P. cornuta*, and *P. disparilis*. Apothecia are not known for some 23 species, of which 14 are sorediate, 8 are isidiate, and only 1 is without soredia or isidia.

Spores are uniformly simple and unicellular in *Amphigymnia* and the only significant variation is in size and in the thickness of the spore wall. There are three major size classes: (1) small thin-walled spores, 12–18 μ long, with the episporium 1.0–1.5 μ thick; (2) intermediate spores, 18–25 μ long, with the episporium 1.5–2.0 μ thick; and (3) large spores, 25–40 μ long, with the episporium 2.0–4.0 μ thick. These three size classes represent at best three clusters on a scale of continuous variation. However, it is not too difficult to assign any given species to one of these classes. The most significant area of intergradation is in species with intermediate or large spores, where *P. abessinica*, *P. austrosinensis*, *P. praesorediosa*, and some others could well be placed in either group.

Examination of tables 1 and 2 will show that spore size is not consistently correlated with other morphological characters. Spore size is, however, strongly correlated with some of the rare acids (table 3). We are inclined to feel that spore size alone is not a valid species character, but it is undeniably a valuable key character in identification work, especially for species with alectoronic acid. There are no species in this monograph based solely on spore size, although there are a few problematic species where there are rather significant differences in spore size (see *P. abnuens* and *P. crinita*). As a rule, wide divergence in spore size is an indication that we are dealing with two species and careful study will often reveal unnoticed differences in other morphological characters that confirm this.

TABLE 3.—*Percentage of species with large, intermediate, or small spores that contain each of 8 different lichen acids.*

(Number of species)	Large (19)	Intermediate (22)	Small (42)
gyrophoric acid	0	4	10
lecanoric acid	0	0	17
alectoronic acid	10	32	19
protocetraric acid	21	27	5
salacinic acid	10	0	26
norstictic acid	0	5	7
stictic acid	21	0	0
usnic acid	5	14	10

The most important apothecial character seems to be the perforate disc, found in at least 27 species. The discs of both small and large apothecia are clearly perforate, leaving a gaping hole which opens directly into the hollow stipe. Nonperforate species have a smooth continuous disc which may split radially with age but only rarely develops a true perforation. This character correlates rather strongly with a number of other characters (table 2), including protocetraric acid, maculae, and white rim. Perforation is apparently a valid

species character, especially in the absence of perforate-nonperforate counterpart species.

Other apothecial characters have been noted but appear to have little immediate value in the taxonomy of *Amphigymnia*. The height of the hymenium, for example, seems to vary in proportion to spore size. Small-spored species have a hymenium 35 to 65 μ high, large-spored species 90 to 130 μ high. In actual practice the height of the hymenium may vary 20 to 30 μ in different specimens of the same species. The size of the thecium is also directly proportional to spore size and has no particular value in descriptions. Pycnidia have not been consistently investigated because they seem to have no importance in the taxonomy of *Amphigymnia*; they are often absent or extremely difficult to find.

ANATOMICAL CHARACTERS

Anatomical characters play no role in the taxonomy of *Amphigymnia* at this time. Dodge (1959) gives a good summary of the internal structure of *Parmelia*. The thickness of the upper cortex and lower cortex depends partly on the age of the thallus so that a number of quite different measurements can be made on the same thallus. The importance of variation in the structure and arrangement of the medullary hyphae or the organization of the algal colonies is as yet unknown. Such variation has been useful in interpreting *Usnea* (Asahina, 1954a), but it has not been used in foliose genera.

Chemistry

The use of color tests in *Parmelia* taxonomy started with Nylander in 1866, and virtually every major lichenologist to date, excepting Müller-Argau and Fink, has used color tests as key characters in the genus. Refinements in identification of the chemicals were brought about by Asahina's microchemical tests (cf. Asahina & Shibata, 1954), which finally placed the nonspecific color reactions on a firm foundation. No one can study *Parmelia* microchemically without being profoundly impressed by the practical importance of lichen acids in species identification. In addition, the presence of certain acids is highly correlated with morphological characters, as previously shown, and geography, indicating that the acids have a more basic value than simply their use in identification work.

Although the chemical color tests are widely used, it is both surprising and disconcerting to find how inaccurate or incomplete are some of the tests reported in the literature by many recent lichenologists. If color tests are used at all, it is imperative that the results be trustworthy. Reports of colors with KOH and P are usually accurate, but

tests with C or KC are often erroneous. The Ca $(O\ Cl)_2$ reagent is all too often old or decomposed and fails to give any color reaction. This reagent should be prepared freshly each day and tested first on *Parmelia tinctorum* or *P. rudecta,* both of which contain lecanoric acid. In this connection it should be mentioned that microchemical tests pose even greater possibilities for error. It is hoped that a suitable manual for identifying lichen acids will appear in the near future and forestall this possibility.

Taxonomy of Chemical Strains

The use of chemistry in lichen taxonomy is a subject of active discussion by present-day lichenologists. The easy application of Asahina's microchemical methods has encouraged more and more workers to use chemical tests. The evidence in favor of using chemistry in identifying and characterizing lichens is now so overwhelming that few modern workers deny its use. The moot point, however, is whether chemical characters alone deserve taxonomic rank, and if so, what this rank should be.

There are now a number of well-documented examples of lichen species that are morphologically inseparable but chemically distinct. *Parmelia* is particularly rich in chemical strains. Many of these chemical variants show more or less clear phytogeographic differences (cf. Culberson & Culberson, 1956; Hale, 1956a), but none has yet been correlated with habitat, substratum, or microclimate. In fact, all evidence so far suggests that chemical strains result from genetic control.

The arguments in favor of species rank for chemical strains are in part pragmatic. Such species are given immediate recognition at the highest possible rank, where they will appear in keys and indexes without danger of being lost. As a corollary, of course, these taxa may be separated in taxonomic lists far from the parent species and the names alone give no inkling of otherwise very close affinities among the species. However, by using species rank, lichenologists are compelled to make more careful and complete identifications and at the same time add to the growing body of data on chemical variation. Even though we cannot yet fully evaluate these data, the fact that most present-day lichenologists ascribe little taxonomic value to chemistry does not preclude the possibility that chemical variation will be of very great importance in future lichen taxonomy. Certainly no one can deny that the taxonomy of *Cladonia* has not been immeasurably clarified and advanced by employing chemistry to the fullest degree.

Another choice is an infraspecific rank. Any infraspecific taxon shares the disadvantages (for bibliographers in particular) of a trinomial system, but at least all chemical variants would appear together in lists or indexes of species. Unfortunately few lichenologists have ever agreed on criteria for recognizing varieties or forms, and in the past these two taxa have been hopelessly abused. Moreover, most taxonomists do not routinely identify species to varietal or other subspecific rank. In other words, if chemical taxa were described as varieties, we would in effect discourage investigation of chemical variation. Literature records would usually refer only to group names, such as *Cladonia chlorophaea* (Flk.) Spreng., and interested taxonomists would have to reexamine the specimens to determine if the chemical variants *C. grayi* Merr., *C. cryptochlorophaea* Asah., etc., were included. The category of subspecies has appeared sporadically in lichen literature and was used to some extent by Runemark (1956) for describing chemical variation in the yellow Rhizocarpons. As far as I am concerned, this taxon has the same disadvantages as any other infraspecific rank.

A last means of recognizing chemical variation is the extra-nomenclatorial device of numbered "chemical strains" first proposed by Lamb (1951) and followed by several lichenologists (cf. Hale 1952). This category fails to provide a stable system of naming strains since it is not subject to rules of nomenclature. However, the use of chemical strain notations has a most acceptable temporary advantage if in a preliminary study we wish to indicate the existence of chemical variation without being forced to propose formal names.

Evidence in subgenus *Amphigymnia* either favoring or opposing taxonomic recognition of chemical variation is at best inconclusive. The species which by any reasonable definition can be considered as chemical strains are listed in table 4. These include 8 parent species (left column) and a total of 10 chemical variants. It is surprising that of the 10 strains, 7 have already been described in the literature, in each case without any cognizance of the older parent name.

Closer study of table 4 shows a preponderance of species with fatty acids or fatty acids and a color reacting acid, most often cryptochlorophaeic or salacinic acids. Of these species, *P. hababiana* (figs. 26, 27), *P. subsumpta*, *P. abessinica*, *P. subcaperata*, *P. xanthina* (but not including *P. aberrans*) (figs. 10–12), *P. subtinctoria*, and their respective chemical strains each have essentially identical distribution patterns and, as far as we can tell, similar habitat requirements. I do not believe that these variants can be considered as distinct species at this time. Both chemical and geographic data suggest variable populations of single species.

TABLE 4.—*Chemical strains in* Amphigymnia.

Strain 1	Strain 2	Strain 3
P. hababiana Gyel. (cryptochlorophaeic +fatty)	unnamed species (fatty)	—
P. abessinica Krempl. (cryptochlorophaeic +fatty)	*P. glaucocarpoides* Zahlbr. (fatty)	—
P. subcaperata Krempl. (salacinic)	*P. recipienda* Nyl. (cryptochlorophaeic +fatty)	—
P. subsumpta Nyl. (salacinic)	unnamed species (cryptochlorophaeic +fatty)	—
P. subtinctoria Zahlbr. (salacinic)	*P. haitiensis* Hale (cryptochlorophaeic +fatty)	unnamed species (salacinic, cryptochlorophaeic, +fatty)
P. xanthina (Müll. Arg.) Vain. (fatty)	*P. madagascariacea* (Hue) des Abb. (KC+unknown+fatty)	*P. aberrans* (Vain.) des Abb. (gyrophoric)
P. perforata (Jacq.) Ach. (norstictic)	*P. rigida* Lynge (alectoronic)	—
P. margaritata Hue (salacinic)	*P. arnoldii* Du Rietz (alectoronic)	—

The three remaining examples show well-defined differences in distribution patterns. *Parmelia margaritata* (fig. 9) is confined to east-central United States, whereas *P. arnoldii* (figs. 9, 16) is common in the mountains of western and eastern North America, Mexico, West Indies, South America, and Europe. *Parmelia xanthina* (in-

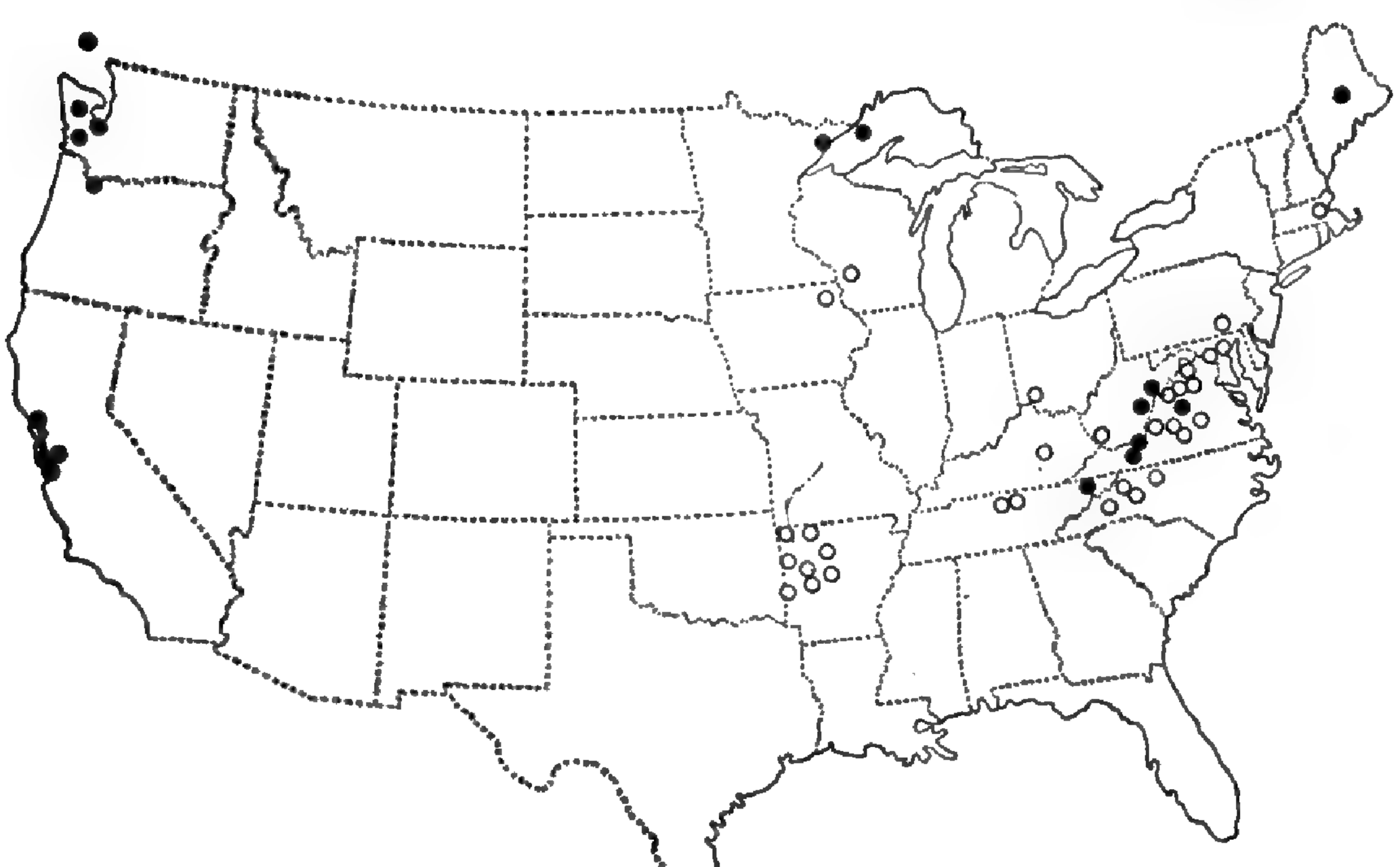
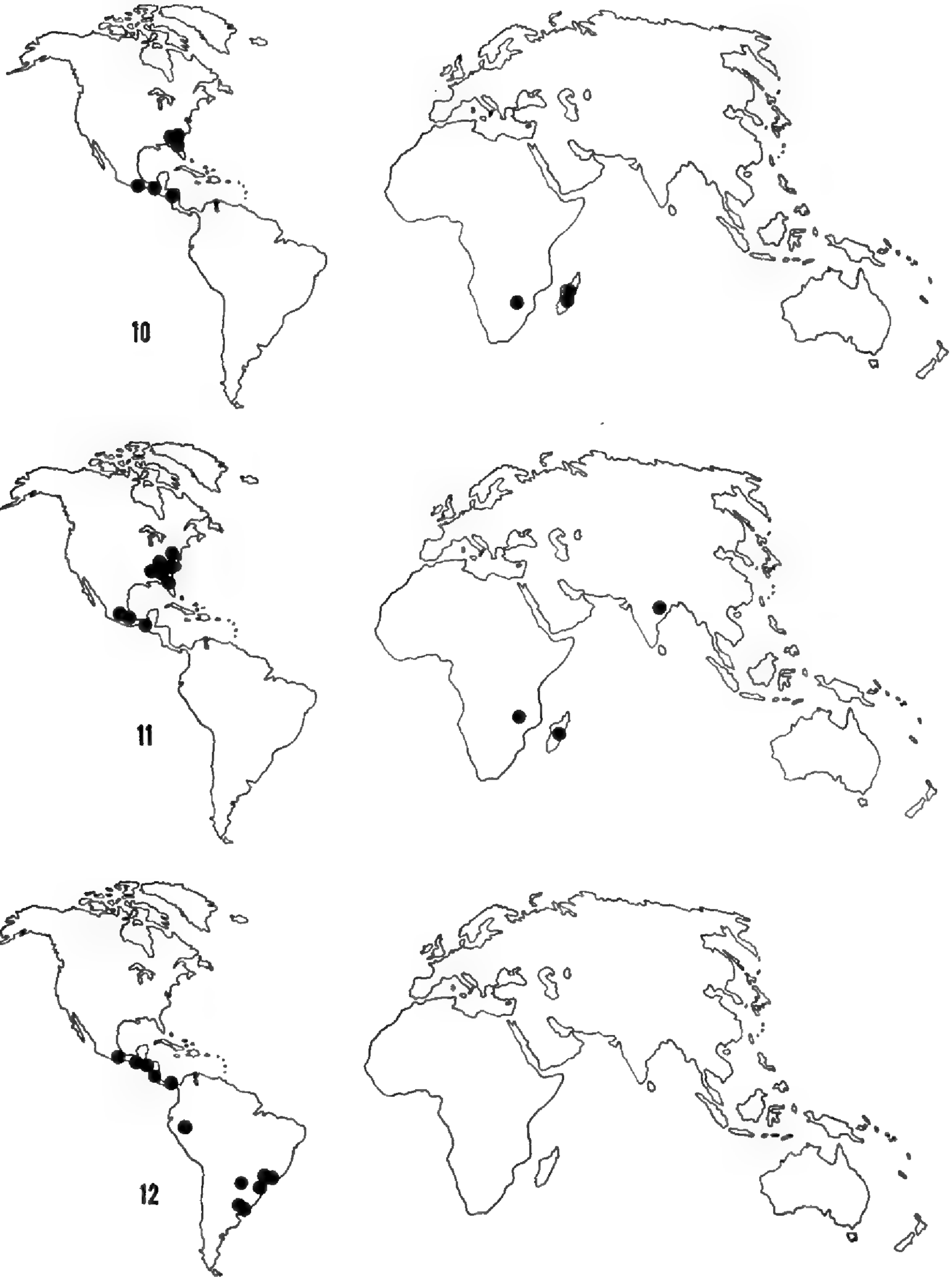


FIGURE 9.—Distribution in the United States of *Parmelia arnoldii* Du Rietz (●) and *P. margaritata* Hue (○).



FIGURES 10–12.—Distribution: 10, *Parmelia xanthina* (Müll. Arg.) Vain. (protolichesteric acid present); 11, *P. madagascariacea* (Hue) des Abb. (KC+ red unknown strain of *P. xanthina*); 12, *P. aberrans* (Vain.) des Abb. (gyrophoric acid present).

cluding *P. madagascariacea*) occurs widely in India, Africa, and North America (figs. 10, 11), but *P. aberrans* (fig. 12) is restricted to tropical America. *Parmelia rigida* occurs in southern South America and, with *P. perforata*, in the southern United States (fig. 29). *Parmelia perforata* extends much farther north in the United States (fig. 7). On the basis of the distribution patterns of these

species and the distinctiveness of the chemicals involved, I propose to recognize *P. arnoldii*, *P. aberrans*, and *P. rigida* as distinct species in addition to the earlier described chemical variants *P. margaritata*, *P. xanthina*, and *P. perforata*.

A definitive solution to the problem of recognizing chemical variation in lichens, if indeed such can ever be attained, must await two developments, a complete manual bringing up to date the identification of lichen acids and far more exhaustive field and herbarium studies of chemical strains. If chemical strains are not worthy of such complete investigation, then they are certainly not worthy of specific epithets and every effort should be made not to encumber the literature with hastily proposed chemical species.

Identification of Lichen Substances

A total of 23 different lichen substances, 15 of them definitely identified, has been demonstrated in the 106 species of *Amphigymnia* treated in this monograph. Almost every specimen examined was chemically tested. The substances were identified with routine microchemical procedures generally used by lichenologists, including color tests (concentrated aqueous solution of KOH, concentrated freshly prepared aqueous solution of Ca (O Cl)$_2$, and a 5% alcoholic solution of paraphenylenediamine ($C_6H_4(NH_2)_2$); Asahina's microchemical tests prepared according to Evans (1943); and chromatography with Whatman No. 1 paper. It must be emphasized that exhaustive analyses were not carried out because of limitations of equipment and space. Our attention was directed primarily at the substances of immediate use in taxonomy.

1. Alectoronic acid. This is the commonest substance, outside of atranorine, occurring in subgenus *Amphigymnia*. It was demonstrated in the following 21 species:

P. argentina
*P. arnoldii**
P. breviciliata
*P. chiapensis**
*P. corniculans**
P. direagens
P. erasmia
P. hypomiltoides
P. maclayana
*P. mellissii**
P. natalensis
*P. nilgherrensis**
P. ornatula
P. pancheri
P. procera
P. pseudonilgherrensis
*P. rampoddensis**
P. rigida
*P. rimulosa**
*P. subrugata**
P. wainii

Alectoronic acid is always deposited in the medulla. It usually occurs with small quantities of α-collatolic acid, but I have usually not attempted to make absolute identification of α-collatolic acid. Species in the above list marked with asterisks may also contain the red-orange pigment rhodophyscin, which is scattered in moribund

parts of the lower medulla. Alectoronic acid is identified by a bright fluorescence test, by the gummy residue from acetone, and by recrystallization in G.A.W. as small fan-shaped lamellae (Asahina, 1938, fig. 73).

2. Atranorine. This lichen substance occurs in varying concentration in all species of subgenus *Amphigymnia*. It is typically produced in the upper cortex where its presence is indicated by a distinct K+ pale-yellow reaction. It also probably occurs in the carbonized lower cortex as well, although here color tests are obscured. Only one species, *P. flavotincta*, contains atranorine in the medulla, a very rare occurrence in *Parmelia*. Atranorine is very easily identified in G.A.o–T. or in G.E. Because of its universal occurrence in *Amphigymnia* species, it has little diagnostic value, and it is merely observed as a constant component when tests are made for other lichen acids, especially with G.A.o–T.

3. Caperatic acid. This fatty acid has been positively identified in three species: *P. diacidula* (as an accessory component), *P. mesotropa*, and *P. praesorediosa*. Unfortunately the identification of lichen fatty acids has not been completely worked out. We have recognized caperatic acid by the formation of dendroid or warty globules in G.E. (cf. Asahina 1959, fig. 2). Caperatic acid is closely related to and probably occurs with protolichesteric acid in other species.

4. Cryptochlorophaeic acid. This acid was first discovered in *Cladonia* but later found in *Parmelia* (Hale, 1959a). Its chemical structure is unknown but it seems to be a depside. It has been found so far in six species of *Amphigymnia:*

P. abessinica
P. hababiana
P. schimperi
P. subcaperata
P. subsumpta
P. subtinctoria

In all of these species it is accompanied by protolichesteric acid, and in *P. subtinctoria* salacinic acid may be present as well. Each of these species, excepting *P. schimperi*, is represented by a chemical strain containing protolichesteric acid alone (*P. abessinica*, and *P. hababiana*) or salacinic acid (*P. subcaperata*, *P. subsumpta*, and *P. subtinctoria*). The medulla of species containing cryptochlorophaeic acid is KC+ deep red. A gummy residue from acetone recrystallizes as long curving needles in G.A.W. It should be noted that no crystals form in G.E.

5. Gyrophoric acid. This acid, widely distributed in lichen genera, occurs in nine species of subgenus *Amphigymnia*:

P. aberrans
P. diacidula
P. euneta
P. hanningtoniana
P. lobulascens
P. lophogena
P. permutata
*P. pseudocrinita**
*P. sancti-angelii**

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In the two species marked with asterisks rhodophyscin is an accessory component. *Parmelia permutata* contains in addition a K— orange-yellow pigment, *P. diacidula* contains caperatic acid, and *P. aberrans* contains usnic acid. The medulla of all of these species reacts C+ rose and the whitish residue from acetone recrystallizes as small warts or granules in G.E. or G.A.W. In problems where it must be absolutely differentiated from olivetoric or lecanoric acids, a chromatographic test is necessary; gyrophoric has a very low R_f value (Hale, 1956b).

6. Lecanoric acid. This acid, structurally related to gyrophoric acid, occurs in eight species, most of them common in Africa:

P. andina
P. austrosinensis
P. cooperi
P. defecta
P. hololoba
P. pseudotinctorum
P. soyauxii
P. tinctorum

The medulla is C+ deep blood red. The thick white acetone residue crystallizes as needle clusters in both G.E. and G.A.W. Chromatographic identification is very easy, lecanoric acid having an R_f range midway between gyrophoric acid and olivetoric acid.

7. Norstictic Acid. This is a rather rare acid in subgenus *Amphigymnia*, occurring in *P. aldabrensis*, *P. crassescens*, *P. hypotropa*, *P. perforata*, and *P. rubifaciens*. It may be intermingled with stictic acid in *P. aldabrensis* and *P. hypotropa*. The medullary color test is K+ yellow turning to red and P+ pale orange. Microchemical identification with G.A.o–T. is extremely simple, with the immediate formation of 4-angled yellow lamellae or small elliptical clusters.

8. Olivetoric acid. The only *Amphigymnia* species containing olivetoric acid are *P. abnuens* and *P. amboimensis*. The medulla is C+ deep red orange. The acetone residue is gummy and recrystallizes with some difficulty in G.A.W. A chromatographic test is usually needed for positive identification.

9. Protocetraric acid. This acid, with salacinic acid, is the second commonest acid in *Amphigymnia*, occurring in these 17 species:

P. blanchetii
*P. conformata**
*P. dilatata**
P. disparilis
*P. dominicana**
P. eborina
*P. fasciculata**
*P. fracta**
P. merrillii
P. pachyspora
P. peralbida
P. saccatiloba
P. setchellii
P. subarnoldii
P. subcorallina
*P. viridiflava**
P. zollingeri

Species with asterisks usually also contain usnic acid, and *P. subcorallina* contains protolichesteric acid. The medullary reaction is K— or faint brownish, C—, KC+ transient rose, and P+ brick red.

The acetone residue is usually small and recrystallizes as yellow balls from G.A.o-T. They can be mistaken for aggregates of salacinic acid (K+ red) but have a deeper color and less soluble residue.

10. Protolichesteric acid. As with caperatic acid, this fatty acid can only be identified with rather unsatisfactory microchemical tests with G.E. In this reagent thin angular or feathery plates are formed (cf. Asahina, 1959, fig. 4), sometimes aggregated and intergrading with caperatic acid. It occurs as the chief component in *P. abessinica* (ch. str.), *P. grayana*, *P. hababiana* (ch. str.), *P. melanothrix*, and in *P. ochroglauca* and *P. xanthina* accompanied with usnic acid. It also occurs as an accessory component in species containing cryptochlorophaeic acid. In *P. subcorallina* it occurs with protocetraric acid, in *P. paulensis* and *P. xanthina* (ch. str.) with unknown KC+ substances, and in *P. crocoides* and *P. cryptoxantha* with unidentified K— pigments. Because of the rather variable crystal shapes in G.E., we are not certain that the only fatty acid in these 14 species is protolichesteric acid or even that true protolichesteric acid is always present. It is hoped that future work in identification of these acids will help solve these problems.

11. Rhodophyscin. This red-orange hydroxyanthraquinone pigment was first discovered in *Physcia endococcinea*. It occurs in ten species of *Amphigymnia* as an accessory component with alectoronic or gyrophoric acids (see lists above under these acids). It reacts K+ deep purple. It is most easily identified with chromatography, forming a distinct spot at R_f .55–.65 (n-butanol-NH_4OH). Rhodophyscin occurs near the lower cortex in thalli that seem moribund or old. It must be carefully distinguished from the unknown K+ pigment No. 1 in *P. erasmia*, *P. hypomiltoides*, and *P. mesogenes* (see below).

12. Salacinic acid. This common K+ acid occurs in 17 species:

P. coralliformis
P. cristifera
*P. delicatula**
P. eurysaca
*P. flavescens**
P. latissima
P. leucosemotheta
P. margaritata
*P. miranda**
P. ramuscula
P. reparata
P. stuppea
P. subcaperata
P. subcrinita
*P. subsumpta**
P. subtinctoria
P. uruguensis

Species with asterisks also usually contain usnic acid; *P. subcaperata*, *P. subsumpta*, and *P. subtinctoria* have chemical strains with cryptochlorophaeic acid. Salacinic acid is first recognized by a deep red color test with K in the medulla. A usually abundant residue from acetone recrystallizes as deep yellow, boat-shaped plates in G.A.o–T. If aggregated, they may be confused at first with norstictic acid, which is also K+ red.

13. Stictic acid. Stictic acid occurs as the main component in only four species, *P. bangii*, *P. crinita*, *P. eciliata*, and *P. perlata*. It is an accessory component with norstictic acid in *P. aldabrensis* and *P. hypotropa*. The medulla reacts persistent K+ yellow and unmistakable colorless hexagons recrystallize in G.A.o–T.

14. Usnic acid. This yellow cortical pigment has been demonstrated in 12 species as an accessory component with gyrophoric acid (*P. aberrans*), protocetraric acid (*P. conformata*, *P. dominicana*, *P. fasciculata*, *P. fracta*, *P. viridiflava*), protolichesteric acid (*P. ochroglauca*, *P. xanthina*), salacinic acid (*P. delicatula*, *P. flavescens*, *P. miranda*), or a KC+ unknown (*P. xanthina*). It is found only rarely and in low concentration in *P. subsumpta*. Usnic acid can be tentatively identified by the yellow color of the thallus and is positively identified by a microchemical test with G.E. or with chromatography.

15. Vulpinic acid. This brilliant lemon-yellow pigment has been found in two species of subgenus *Amphigymnia*: *P. cornuta* and *P. sulphurata*. Microchemical identification can be made with G.E. (cf. Asahina, 1954b). Care should be taken not to confuse this pigment with other unidentified K— pigments (see below) which are pale yellow orange or yellow.

16. Unidentified hydroxyanthraquinone pigment No. 1. This conspicuous red-orange pigment occurs in the medulla of *P. erasmia* and *P. hypomiltoides*, both of which also contain alectoronic acid, and in *P. mesogenes*, which contains unknown substances. This pigment forms a streak with a lower R_f than rhodophyscin. It is more or less uniformly deposited, generally near the lower cortex, even at lobe tips, and is not associated with moribund parts of the medulla.

17. Unidentified K— pigment No. 1. The following six species contain the same pale yellow-orange pigment, heavily concentrated in the medulla of apothecia and in the lower half or all of the medulla: *P. appendiculata*, *P. araucariarum*, *P. endosulphurea*, *P. myelochroa*, *P. permutata*, and *P. subcolorata*. This pigment is accompanied by gyrophoric acid in *P. permutata*. In the remaining species the accompanying components have not been identified. Barbatic acid is suspected but not yet positively identified. The K, C, and P reactions are vague and microchemical tests have been fruitless.

18. Unidentified K— pigment No. 2. Two species, *P. cryptoxantha* and *P. ebulliens*, contain traces of a very faint unidentified yellow pigment.

19. P+ Unknown. *Parmelia direagens*, in addition to alectoronic acid, contains an unidentified P+ substance in the soredia, which forms deep-yellow warts in G.A.o-T.

20. K+ Unknown. *Parmelia inexspectata* contains an unknown

K+, P— substance which has not been identified with any crystal tests.

21. Unknown KC+ substance No. 1. One chemical strain of *P. xanthina* (*P. madagascariacea* strain) reacts KC+ red. Abundant colorless needles and aggregate clusters form in G.E., but they have not been identified.

22. Unknown KC+ substance No. 2. This unidentified compound is found in *P. paulensis*. It reacts KC+ faint red; no identification has been made.

23. Unknown substances. *Parmelia mesogenes* Nyl. contains a colorless substance that is unreactive with color tests. It forms large needle clusters in G.E.

Geographical Distribution

Phytogeography of lichens is actually no more than a presentation of known distribution patterns interpreted with reference to patterns already established for phanerogams and ferns. Higher plants have a fossil record, and there is a more or less coherent link between modern and fossil forms. Lichens have no fossil records and we know nothing of their evolution in geological ages. We will therefore confine our discussions here to a summary of the distribution patterns. These discussions must be tempered with the fact that more thorough collecting will undoubtedly extend the distributions of many of the species now considered to be endemic.

The following 26 species are pantropical. By our definition this means that they have been found on at least three of the major continental areas, North or South America, Europe, Africa, Asia, and Australia, although they may be very rare in some parts of their ranges.

P. andina (fig. 5)
P. austrosinensis (fig. 6)
P. breviciliata (fig. 23)
P. crinita (fig. 17)
P. cristifera (fig. 4)
P. dilatata
P. endosulphurea (fig. 14)
P. euneta
P. hababiana (figs. 26, 27)
P. hypotropa
P. mellissii
P. perlata (fig. 20)
P. permutata
P. praesorediosa (fig. 15)
P. rampoddensis
P. sancti-angelii
P. stuppea (fig. 21)
P. subarnoldii
P. subcrinita
P. subrugata
P. subsumpta
P. subtinctoria (fig. 24)
P. sulphurata (fig. 22)
P. tinctorum
P. xanthina (figs. 10, 11)
P. zollingeri

The most interesting observation that can be made on the cosmopolitan species is that half of them (13) are sorediate. Only five species (*P. andina*, *P. breviciliata*, *P. euneta*, *P. subrugata*, and *P. zollingeri*) lack soredia and isidia.

The following 30 species are endemic to the Americas. Many of these are restricted to Mexico, the West Indies, or South America, as may be seen in the lists of localities below. In contrast to the pantropical species, half (15) of the species here lack soredia and isidia. Only eight are sorediate.

P. aberrans (fig. 12)
P. abnuens
P. araucariarum
P. argentina
P. bangii
P. blanchetii
P. chiapensis
P. coralliformis
P. cornuta
P. crassescens
P. crocoides
P. delicatula
P. eborina
P. ebulliens
P. erasmia
P. eurysaca
P. flavescens
P. flavotincta
P. fracta
P. hypomiltoides
P. margaritata
P. mesogenes
P. mesotropa
P. miranda
P. myelochroa
P. peralbida
P. rigida
P. rubifaciens
P. uruguensis
P. viridiflava

Twenty-two species have been found only in Africa, mostly central and southern Africa. As in the Americas, about half of them lack soredia and isidia.

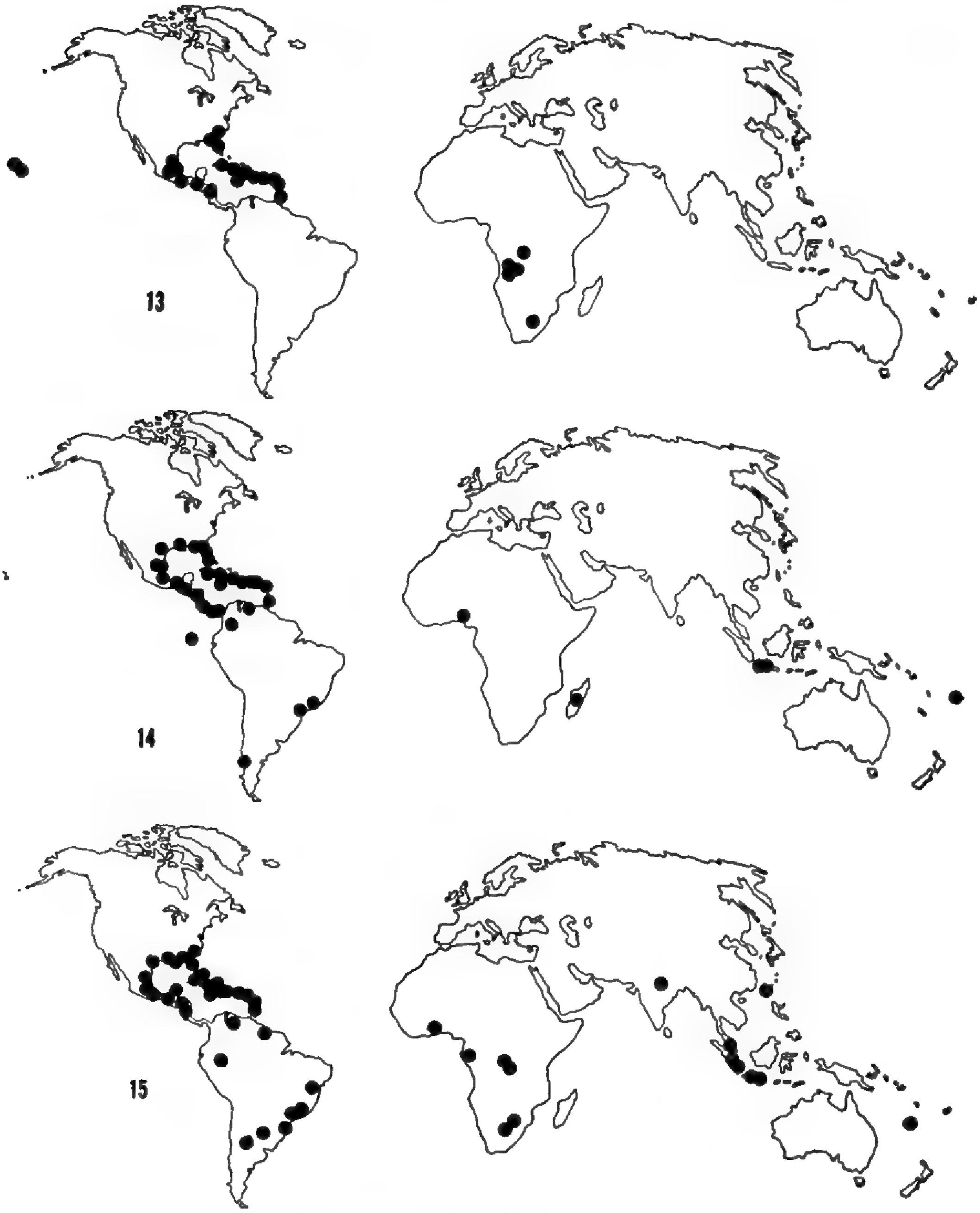
P. amboimensis
P. cooperi (fig. 25)
P. cryptoxantha
P. defecta
P. diacidula
P. direagens
P. hanningtoniana
P. hololoba
P. inexpectata
P. lobulascens
P. lophogena
P. maclayana
P. natalensis
P. ochroglauca
P. ornatula
P. pachyspora
P. pseudocrinita
P. pseudotinctorum
P. rimulosa
P. schimperi
P. soyauxii
P. subcolorata

Seven species occur only in tropical America and Africa:

P. abessinica
P. conformata
P. disparilis
P. eciliata (fig. 18)
P. fasciculata
P. leucosemotheta
P. wainii

Three additional species, *P. appendiculata*, *P. melanothrix*, and *P. paulensis*, are typically American but have disjunct distributions in Madagascar or nearby islands.

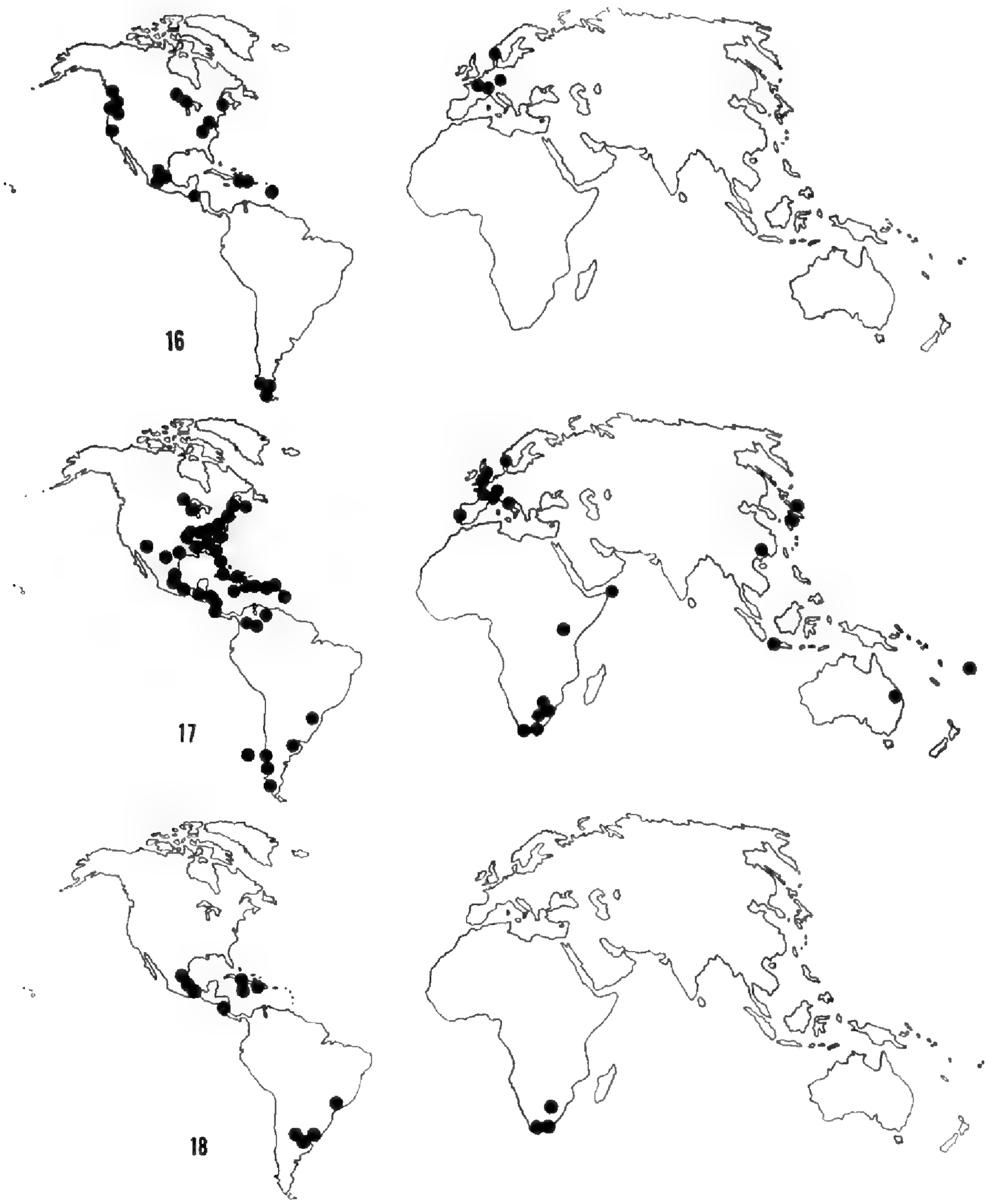
Only four species, *P. corniculans*, *P. merrillii*, *P. nilgherrensis* (fig. 28), and *P. subcorallina*, are restricted to Asia. Two species, *P. grayana* (fig. 19) and *P. pseudonilgherrensis*, occur in Asia and in Africa.



FIGURES 13–15.—Distribution: 13, *Parmelia dominicana* Vain.; 14, *Parmelia endosulphurea* (Hillm.) Hale; 15, *Parmelia praesorediosa* Nyl.

Three species, *P. ramuscula*, *P. saccatiloba*, and *P. setchellii*, are endemic to the Pacific region. On the whole, this region has a very poor *Amphigymnia* flora.

Two species, *P. reparata* and *P. subcaperata*, have an unusual distribution in America and Australia–New Zealand. These may eventually prove to be pantropical, although their absence in Africa seems reasonably well established. It should be noted in passing that there are no *Amphigymnia* species endemic to Australia or New Zealand.



FIGURES 16–18.—Distribution: 16, *Parmelia arnoldii* Du Rietz; 17, *Parmelia crinita* Ach.; 18, *Parmelia eciliata* (Nyl.) Nyl.

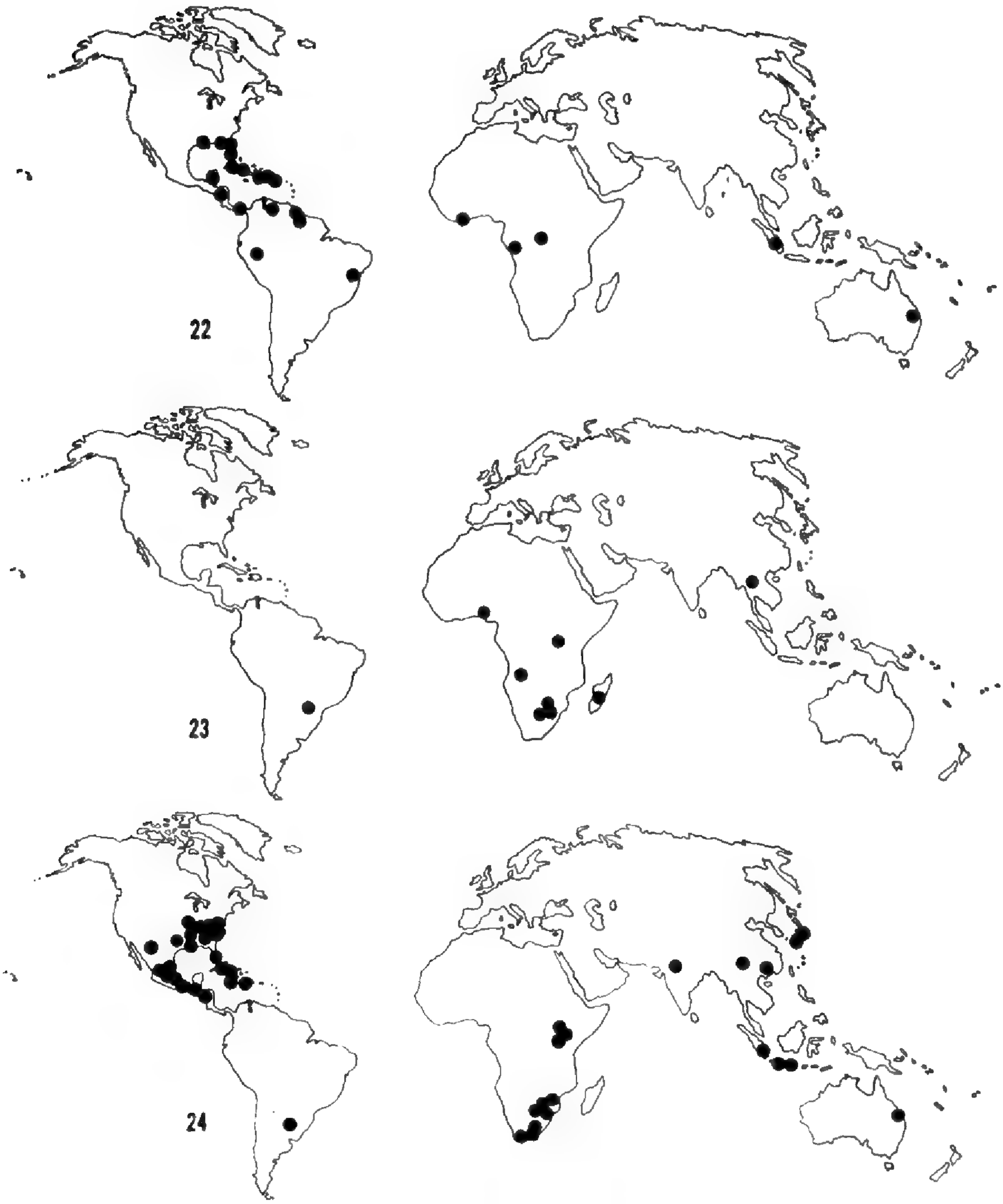
The remaining species are not easily classified. These include *P. aldabrensis* (Africa, India Ocean), *P. arnoldii* (temperate North and South America, Europe), *P. dominicana* (Hawaii, Tropical America, Africa), *P. latissima* (Tropical America, India), *P. pancheri* (New Caledonia, Asia), *P. perforata* (North America, Europe, Madagascar), and *P. procera* (Africa, Asia, New Caledonia).

A further breakdown of the species according to the total number in various geographic areas is instructive and shows parallelism with

FIGURES 19–21.—Distribution: 19, *Parmelia grayana* Hue; 20, *Parmelia perlata* (Huds.) Ach.; 21, *Parmelia stuppea* Tayl.

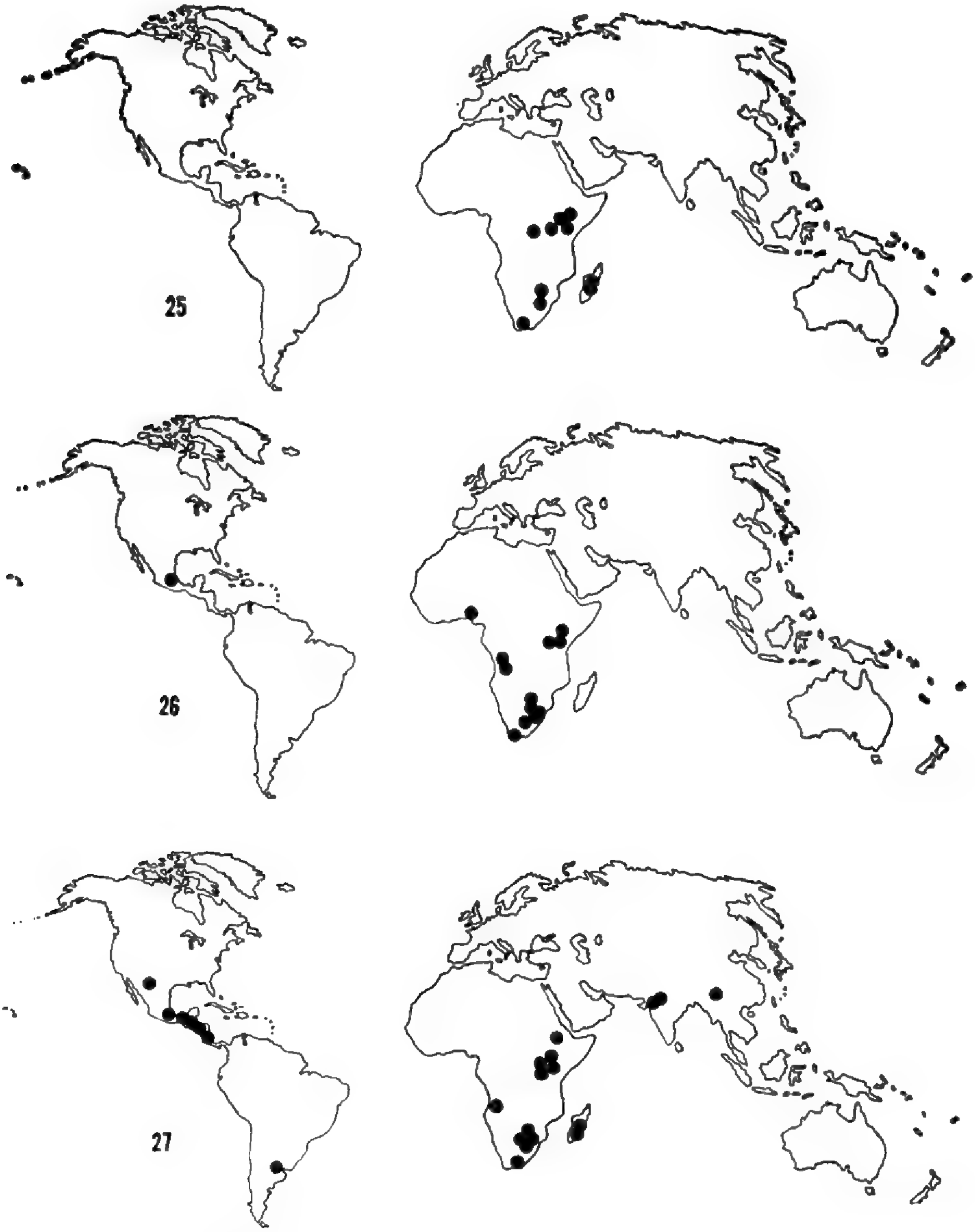
the degree of endemicity. North America north of Mexico has an *Amphigymnia* flora of 25 species, Mexico and Central America 47, the West Indies 27, and South America 51. Europe has only 8 species (*P. arnoldii*, *P. austrosinensis*, *P. crinita*, *P. dilatata*, *P. hypotropa*, *P. perforata*, *P. perlata*, and *P. stuppea*). Africa has a grand total of 64 species, making it the richest area. Asia has 36 species, the Pacific region 10, and Australia and New Zealand 17.

The ecology of the *Amphigymnia* species seems to be comparatively



FIGURES 22–24.—Distribution: 22, *Parmelia sulphurata* Nees & Flot.; 23, *Parmelia breviciliata* Hale.; 24, *Parmelia subtinctoria* Zahlbr. (specimens with salacinic acid).

simple. Almost all of them flourish best in open rather dry deciduous forests or savannas at low to medium elevation. In dense deciduous forests the typical habitat is the canopy branches. In open savannas or pastures or on shade trees in coffee or banana plantations the lower trunks are thickly covered with Amphigymnias. At sea level the most commonly collected species are the pantropical weeds such as *P. praesorediosa* and *P. tinctorum*. The richest development of species, at least in the tropics, appears to be at elevations between 500 and 2000 m. Few species are found above 3000 m.



FIGURES 25–27.—Distribution: 25, *Parmelia cooperi* Stein. & Zahlbr.; 26–27, *Parmelia hababiana* Gyel.: 26, protolichesteric acid strain (=*P. glaucocarpoides* Zahlbr.); 27, cryptochlorophaeic acid strain).

Subgeneric Classification

The number of previously described subgeneric taxa in *Amphigymnia* is small and most of them, in fact, have been proposed by only two lichenologists, Vainio and Gyelnik. The typification of these few names, however, has been extremely difficult, mainly because Vainio's classification, used by almost all lichenologists, is based on

color of the thallus (presence or absence of usnic acid), a character which we have found to be of secondary importance. Because of this, it might be well to review first the important morphological characters that we have determined in subgenus *Amphigymnia*, especially with respect to their possible use in setting up a subgeneric classification. These data may be summarized as follows:

1. Isidia, soredia, and the lack of isidia and soredia in general show very weak association with other morphological and chemical characters. There was rather significant correlation between sorediate–NIS species but not enough to justify splitting them from the isidiate species.

2. Maculae, cilia, and perforate apothecia all show a high degree of association with each other and with white rim below.

3. Spore size is not consistently correlated with any characters outside of some of the rarer acids.

4. The presence of usnic acid is a rather rare trait negatively associated with maculae and perforate apothecia.

After considering these data, we must conclude that there is no one dominating character that will immediately divide *Amphigymnia* into natural sections. The primary characters are cilia, maculae, perforate apothecia, and white rim below, all of which are mutually associated and show strong association with some of the lichen acids. Of these four characters, perforate apothecia are least usable because nearly 25% of the species are sterile. Maculae are useful but are difficult to recognize without considerable experience. White rim below can also be troublesome to distinguish and is a relatively rare character. This leaves cilia as the most likely and certainly the most easily recognized character for a major sectional division.

If we proceed now to a study of subgeneric taxa proposed by past workers, we find only one basic system, which was first proposed by Vainio (1890) as the result of his experience with the lichen flora of Rio de Janeiro. He divided *Parmelia* into three sections: *Amphigymnia*, *Hypotrachyna* (=*Parmelia*), and *Xanthoparmelia*. These sections, now recognized as subgenera, were carefully delimited for the most part and have been correctly interpreted by most lichenologists. In this monograph our attention will be directed only at subgenus *Amphigymnia*.

Within section *Amphigymnia*, Vainio erected two groups without formal rank, based entirely on color of the thallus: *Subglaucescentes*, gray species (lacking usnic acid) and *Subflavescentes*, the yellow-green species (usnic acid present). As far as we know, no one has ever attempted to typify Vainio's subgeneric taxa. It seems reasonable to assume that he considered *Subglaucescentes* to be the typical group in *Amphigymnia* since it is the largest and is presented first. The

Subflavescentes by contrast is a smaller group of only three species. The selection of a lectotype for *Subflavescentes* is not difficult since the species listed here by Vainio all contain usnic acid and are ciliate. *Parmelia delicatula* seems to be the most suitable type species and has also been mentioned as such by Gyelnik (1932, p. 225).

The eight species assigned by Vainio to *Subglaucescentes* form a motley group, some ciliate, some nonciliate. Selection of a type must unfortunately be arbitrary. Since the lectotype of *Subflavescentes* is ciliate, it would seem desirable to select a nonciliate species for *Subglaucescentes*, especially in view of our reliance on cilia as a primary character. The best known nonciliate species listed is *P. tinctorum* Nyl. (identified by Vainio as *P. coralloidea* (Mey. & Flot.) Vain.), a common pantropical species. As will be seen, Gyelnik also defined *Subglaucescentes* as including typically nonciliate species as well as ciliate ones.

The second major subgeneric classification for the Amphigymnias was proposed by Gyelnik in 1932. It is essentially a modification of Vainio's. Gyelnik did not recognize section *Amphigymnia* but adopted in its place two sections, *Subflavescentes* (Vain.) Gyel. and *Subglaucescentes* (Vain.) Gyel., and created within each section parallel nonciliate–ciliate subsections as follows:

Section *Subflavescentes* (Vain.) Gyel.
  Subsection *Eciliatae* Gyel. (lectotype *P. caperata*)
  Subsection *Ciliatae* Gyel. (type *P. delicatula*)
Section *Subglaucescentes* (Vain.) Gyel.
  Subsection *Eciliolae* Gyel. (lectotype *P. perlata*)
  Subsection *Ornaticolae* Gyel. (lectotype *P. perforata*)

Gyelnik made several errors which make typification rather arbitrary. Of three species listed for subsection *Eciliatae*, one (*P. kernstockii* Lynge & Zahlbr.=*P. flaventior* Stirt.) is pseudocyphellate and two (*P. soredians* Nyl. and *P. caperata* (L.) Ach.) belong in subgenus *Parmelia*. *Parmelia perlata*, the type of subsection *Eciliolae*, is actually ciliate and it is possible that Gyelnik did not interpret this species correctly.

Our studies correlating morphology and chemistry in *Amphigymnia* have convinced us that thallus color is useless as a sectional character. If our assessment of the importance of cilia is correct, Gyelnik has come closest to a natural subdivision of subgenus *Amphigymnia*, although it is complicated by his acceptance of Vainio's two color based groups. By recombining taxa described by Vainio and Gyelnik, we are proposing the following classification. Typification and discussions of each taxon will be presented below in the list of species.

Subgenus *Amphigymnia* (Vain.) Dodge
  1. Section *Amphigymnia* (Section *Subglaucescentes* (Vain.) Gyel.)

2. Section *Subflavescentes* (Vain.) Gyel.
   Subsection *Subflavescentes*
      Series *Subflavescentes*
      Series *Emaculatae* Hale
   Subsection *Ornaticolae* Gyel.
      Series *Subpallidae* Hale
      Series *Ornaticolae*

Key to the Subgeneric Taxa

1. Margins and apices of lobes without cilia or axils of lobes rarely sparsely ciliate . . . . . 1. Section **Amphigymnia**
1. Margins and apices of lobes distinctly ciliate . . 2. Section **Subflavescentes**
   2. Upper cortex without distinct maculae . . . . Subsection **Subflavescentes**
      3. Thallus yellow (usnic acid) . . . . . Series **Subflavescentes**
      3. Thallus mineral gray (usnic acid lacking) . . . . . Series **Emaculatae**
   2. Upper cortex distinctly maculate . . . . . Subsection **Ornaticolae**
      4. Lower side uniformly pale brown, short rhizinate to the margins. Series **Subpallidae**
      4. Lower side black and rhizinate in the center, brown to white or mottled and naked along the margins . . . . . Series **Ornaticolae**

Artificial Key to Species

1. Thallus isidiate, sorediate-isidiate, or pustulate . . . . . I.
1. Thallus lacking isidia.
   2. Thallus sorediate or pustulate . . . . . II (p. 230).
   2. Thallus lacking soredia or pustules . . . . . III (p. 232).

I. THALLUS ISIDIATE, SOREDIATE-ISIDIATE, OR PUSTULATE

1. Margins of lobes smooth, without cilia.
   2. Medulla pale yellow orange . . . . . **13. P. endosulphurea**
   2. Medulla white.
      3. Thallus yellowish green, usnic acid present.
         4. Isidia normal, to 1 mm. high, laminal . . . . . **31. P. conformata**
         4. Isidia coralloid, to 5 mm. high, mostly marginal . . **14. P. fasciculata**
      3. Thallus mineral gray to buff, usnic acid lacking.
         5. Isidia coralloid, to 5 mm. high, mostly marginal.
            6. Medulla K+ red (salacinic acid) . . . . . **23. P. ramuscula**
            6. Medulla K−, P+ red (protocetraric acid) . . . **14. P. fasciculata**
         5. Isidia laminal, to 1 mm. high, not conspicuously coralloid.
            7. Isidia very thick, 0.2–0.3 mm. in diameter.
               8. Medulla C+ red (lecanoric acid); Africa . **22. P. pseudotinctorum**
               8. Medulla C−, P+ red (protocetraric acid); Pacific region. **26. P. setchellii**
            7. Isidia thin, usually less than 0.1 mm. thick.
               9. Medulla C+ red (lecanoric acid) . . . . . **28. P. tinctorum**
               9. Medulla C−, P+ red (protocetraric acid).
                  10. Thallus coriaceous; spores large; Pacific region. **25. P. saccatiloba**
                  10. Thallus membranous; spores small; tropical America. **20. P. peralbida**
1. Margins of lobes distinctly ciliate.
   11. Medulla deep lemon yellow, K− . . . . . **78. P. sulphurata**

11. Medulla white or pigmented, pigment K+ purple.
12. Thallus yellowish green, usnic acid present.
13. Lower side pale below, short rhizinate or papillate to the margin.
82. P. subtinctoria
13. Lower side jet black, the margins naked.
14. Medulla K+ red or brown.
15. Plants saxicolous; salacinic acid present . . . **33. P. flavescens**
15. Plants corticolous; protocetraric and fumarprotocetraric acid present . . . . . **31. P. conformata**
14. Medulla K−.
16. Medulla P+ red (protocetraric and fumarprotocetraric acid).
31. P. conformata
16. Medulla P−.
17. Medulla C+ rose (gyrophoric acid) . . . . . **30. P. aberrans**
17. Medulla C−, KC− or KC+ rose . . . . . **37. P. xanthina**
12. Thallus mineral or ashy gray to buff, usnic acid lacking.
18. Isidia coralloid, marginal, 1–5 mm. high.
19. Cortex heavily white maculate . . . . . **88. P. coralliformis**
19. Cortex emaculate.
20. Medulla K+ yellow (atranorine) . . . . . **54. P. flavotincta**
20. Medulla K− (alectoronic acid) . . . . . **63. P. mellissii**
18. Isidia simple to moderately branched, to 1 mm. high.
21. Isidia thick, pustular; medulla C+ rose (gyrophoric acid).
60. P. lophogena
21. Isidia thin, not pustulate (but sometimes sorediate); medulla C−.
22. Isidia in part granular or sorediate.
23. Medulla P+ red (protocetraric acid) . . **76. P. subcorallina**
23. Medulla P−.
24. Alectoronic acid present . . . . . **63. P. mellissii**
24. Protolichesteric acid present . . . . . **98. P. paulensis**
22. Isidia normal, cylindrical.
25. Medulla in part orange red, pigment K+ purple.
26. Medulla C+ rose (gyrophoric acid); Africa.
70. P. pseudocrinita
26. Medulla C− (alectoronic acid); Central America and Mexico.
52. P. erasmia
25. Medulla entirely white.
27. Lower side uniformly brown, short rhizinate to the margin.
82. P. subtinctoria
27. Lower side jet black, the margins more or less naked.
28. Medulla C+ rose (gyrophoric acid); Africa.
70. P. pseudocrinita
28. Medulla C−; cosmopolitan species.
29. Medulla K+ persistent yellow (stictic acid).
47. P. crinita
29. Medulla K+ red (salacinic acid).
30. Cortex strongly maculate; lower side rhizinate or papillate to margin, pale brown in a broad zone.
82. P. subtinctoria
30. Cortex emaculate or faintly maculate; lower side naked and shiny dark brown along the margins.
77. P. subcrinita

II. THALLUS SOREDIATE OR PUSTULATE

1. Margins of lobes smooth, without cilia.
   2. Medulla pale yellow orange . . . . . **2. P. araucariarum**
   2. Medulla white.
      3. Medulla K+ red.
         4. Soredia farinose, soralia elongate; thallus loosely attached; salacinic acid present . . . . . **5. P. cristifera**
         4. Soredia more or less conglutinated, soralia irregular; thallus adnate; norstictic acid present . . . . . **24. P. rubifaciens**
      3. Medulla K− or K+ brownish.
         5. Medulla P+ red (protocetraric acid).
            6. Soredia farinose, yellowish, usnic acid abundant . **10. P. dominicana**
            6. Soredia granular, white, usnic acid usually absent . . **8. P. dilatata**
         5. Medulla P−.
            7. Medulla C−, KC− (caperatic acid) . . . . . **21. P. praesorediosa**
            7. Medulla C+, KC+ red (lecanoric acid).
               8. Plants saxicolous, dark below at the margin . . . . **7. P. defecta**
               8. Plants corticolous, often pale or white rimmed below. **3. P. austrosinensis**

1. Margins of lobes ciliate.
   9. Thallus yellowish green, usnic acid present.
      10. Lower side pale, short rhizinate to the margin . . . **81. P. subsumpta**
      10. Lower side black, naked at the margin.
         11. Soredia laminal in extensive pustules . . . . . **55. P. fracta**
         11. Soredia marginal or submarginal in linear soralia.
            12. Medulla K+ red (salacinic acid); Mexico . . . . **34. P. miranda**
            12. Medulla K− or K+ brown.
               13. Medulla P− (protolichesteric acid); Africa . **35. P. ochroglauca**
               13. Medulla P+ red (protocetraric acid); tropical America. **36. P. viridiflava**
   9. Thallus mineral or whitish gray to buff, usnic acid absent.
      14. Soredia chiefly laminal, often originating from extensive pustular eruptions.
         15. Soralia orbicular; thallus coriaceous, upper cortex maculate; Africa. **96. P. natalensis**
         15. Soralia originating from irregular cracks and pustules; thallus membranous, cortex emaculate.
            16. Medulla K−, P− (alectoronic acid); South Africa . **72. P. rimulosa**
            16. Medulla K+ yellow or red, P+ yellowish.
               17. Stictic acid present; South America . . . . . **42. P. bangii**
               17. Stictic acid absent; Africa . . . . . **48. P. cryptoxantha**
      14. Soredia chiefly marginal, pustules lacking.
         18. Medulla in part with red or yellow-orange pigments.
            19. Pigments K−; medulla C+ rose (gyrophoric acid). **68. P. permutata**
            19. Pigments K+ purple.
               20. Medulla C+ rose (gyrophoric acid) . . . **73. P. sancti-angelii**
               20. Medulla C−, KC+ red (alectoronic acid).
                  21. Pigment conspicuous throughout the medulla; soredia submarginal and subisidiate . . . . . **58. P. hypomiltoides**
                  21. Pigment scattered near the lower cortex; soredia farinose.

22. Soredia originating submarginally; sorediate lobes revolute.
41. P. arnoldii

22. Soredia terminal; sorediate lobes involute.
71. P. rampoddensis

18. Medulla white, pigments absent.
23. Medulla K+ yellow or yellow turning red.
24. Cortex distinctly maculate.
25. Lower side usually pale, rhizinate or papillate to the margin.
81. P. subsumpta

25. Lower side black, brown or white and naked along the margins.
26. Lower side with a white marginal rim; norstictic or stictic acid present . . . . . **92. P. hypotropa**

26. Lower side brown along the margins; salacinic acid present.
93. P. leucosemotheta

24. Cortex dull, emaculate.
27. Soralia linear, terminal. . . . . **74. P. stuppea**

27. Soralia orbicular to sublinear, submarginal, the sorediate lobes revolute.
28. Soralia chiefly on lobe margins, mostly linear; stictic acid present . . . . . **67. P. perlata**

28. Soralia chiefly on marginal lobules or laciniae, mostly orbicular; salacinic acid present . . . . . **62. P. margaritata**

23. Medulla K−.
29. Medulla P+ red.
30. Only soredia reacting P+ orange red; South Africa.
50. P. direagens

30. Soredia and medulla both reacting P+ orange red; pantropical.
31. Cilia produced densely around lobe tips; soralia linear.
75. P. subarnoldii

31. Cilia sparse or absent at lobe tips; soralia irregular.
8. P. dilatata

29. Medulla P−.
32. Medulla C+ rose or red.
33. Cortex distinctly maculate.
34. Medulla C+ rose (gyrophoric acid) . . **94. P. lobulascens**

34. Medulla C+ red (lecanoric acid) . . . . **87. P. cooperi**

33. Cortex emaculate or in part faintly maculate.
35. Medulla C+ red (lecanoric acid) . . . . **87. P. cooperi**

35. Medulla C+ rose (gyrophoric acid).
36. Soralia farinose, linear; pantropical.
73. P. sancti-angelii

36. Soralia coarse, irregular; caperatic acid present; South Africa . . . . . **49. P. diacidula**

32. Medulla C−.
37. Lower side rhizinate or papillate to the margin, pale in a broad zone . . . . . **81. P. subsumpta**

37. Lower side with a broad naked zone, jet black at the center, pale or dark brown at the margin.
38. Cortex maculate.
39. Lower side with a broad ivory zone. . **90. P. hababiana**

39. Lower side dark brown at the margins.
100. P. pseudonilgherrensis

38. Cortex emaculate; lower side dark at the margin.
40. Medulla KC− (protolichesteric acid); Africa and Asia. **56. P. grayana**
40. Medulla KC+ red (alectoronic acid); pantropical.
41. Soralia in part submarginal; sorediate lobes revolute. **41. P. arnoldii**
41. Soralia terminal; sorediate lobes involute. **71. P. rampoddensis**

III. THALLUS LACKING SOREDIA OR PUSTULES

1. Margins of lobes lacking cilia.
2. Medulla pigmented orange red or yellow.
3. Pigment K+ purple . . . . . **16. P. mesogenes**
3. Pigment K−.
4. Pigment pale yellow; acetone residue bubbling in G.E. **12. P. ebulliens**
4. Pigment yellow orange; acetone residue not bubbling.
5. Protolichesteric acid present . . . . . **6. P. crocoides**
5. Fatty acids lacking . . . . . **18. P. myelochroa**
2. Medulla white.
6. Medulla K+ red.
7. Spores 28–32 μ; salacinic acid present . . . . . **15. P. latissima**
7. Spores 20–25 μ; norstictic acid present . . . . . **4. P. crassescens**
6. Medulla K− or K+ brownish.
8. Medulla P+ orange red.
9. Plants saxicolous; spores 11–16 μ long . . . . . **11. P. eborina**
9. Plants corticolous; spores 16–22 μ long.
10. Cortex maculate; margins laciniate . . . . . **9. P. disparilis**
10. Cortex emaculate; margins smooth, rarely laciniate. **29. P. zollingeri**
8. Medulla P−.
11. Medulla C+ red (lecanoric acid).
12. Plants saxicolous; Africa . . . . . **27. P. soyauxii**
12. Plants corticolous; pantropical . . . . . **1. P. andina**
11. Medulla C−.
13. Medulla KC+ red (alectoronic acid) . . . . . **19. P. pancheri**
13. Medulla KC−.
14. Spores 26–28 μ; unknown substance effervescent in G.E. **12. P. ebulliens**
14. Spores 16–21 μ; caperatic acid present . . . **17. P. mesotropa**

1. Margins of lobes ciliate.
15. Thallus yellowish green, usnic acid present; South America. **32. P. delicatula**
15. Thallus whitish or mineral gray to buff, usnic acid lacking.
16. Medulla, at least in part, pigmented yellow or orange yellow.
17. Pigment K−, present in most of the medulla.
18. Exciple of apothecia entire, disc perforate; Africa. **104. P. subcolorata**
18. Exciple dentate or laciniate disc imperforate.
19. Vulpinic acid present . . . . . **46. P. cornuta**
19. Unknown orange-yellow pigments present . **40. P. appendiculata**

17. Pigment K+ purple, scattered near the lower cortex.
20. Spores 18–24 μ; cortex more or less distinctly maculate.
21. Thallus coriaceous, strongly maculate; lobes adnate; Asia.
97. P. nilgherrensis
21. Thallus membranous, weakly maculate; lobes suberect; tropical America . . . . . **86. P. chiapensis**
20. Spores 28–34 μ; cortex not distinctly maculate.
22. Apothecia imperforate; pantropical . . . . . **105. P. subrugata**
22. Apothecia perforate; Asia . . . . . **45. P. corniculans**
16. Medulla white, pigments lacking.
23. Apothecia present.
24. Apothecial disc imperforate.
25. Medulla K+ yellow or red, P+ yellow.
26. Stictic acid present; tropical America and South Africa.
51. P. eciliata
26. Unknown acid present; Africa . . . . . **59. P. inexspectata**
25. Medulla K−.
27. Medulla P+ red (protocetraric acid).
28. Spores large, 26–34 μ, the episporium 2–4 μ thick.
29. Lobe margins and frequently apothecia laciniate; Asia.
64. P. merrillii
29. Lobes and apothecia entire; Africa . . **66. P. pachyspora**
28. Spores small or intermediate, to 22 μ long, the episporium less than 2 μ thick.
30. Spores small, 10–15 μ long; thallus saxicolous.
43. P. blanchetii
30. Spores intermediate, 18–22 μ long; thallus corticolous.
29. P. zollingeri
27. Medulla P−.
31. Medulla C+ rose or red.
32. Spores large, 22–34 μ long; South America. **38. P. abnuens**
32. Spores small, 10–14 μ long; Africa . **39. P. amboimensis**
31. Medulla C−.
33. Spores large, 24–34 μ long.
34. Medulla KC− (protolichesteric acid).
95. P. melanothrix
34. Medulla KC+ (alectoronic acid).
35. Lower side pale at the margin; exciple dentate; pantropical . . . . . **105. P. subrugata**
35. Lower side dark brown, exciple entire; Asia.
97. P. nilgherrensis
33. Spores small or intermediate, to 22 μ long.
36. Cortex maculate.
37. Exciple ciliate; white rim below; alectoronic acid present; tropical America . . . . **85. P. argentina**
37. Exciple entire; margin dark brown below; cryptochlorophaeic acid present; Africa. **103. P. schimperi**
36. Cortex emaculate.
38. Plants saxicolous . . . . . **44. P. breviciliata**
38. Plants corticolous.

39. Cilia dense; spores 18–22 μ long . . **79. P. wainii**
39. Cilia sparse; spores 12–16 μ long . . **69. P. procera**

24. Apothecia perforate.
40. Spores large, 28–34 μ long . . . . . **45. P. corniculans**
40. Spores small or intermediate, to 22 μ long.
41. Medulla K+ red.
42. Cortex dull, emaculate . . . . . **53. P. eurysaca**
42. Cortex shiny, maculate.
43. Lower side with black center and white rim around the margin . . . . . **99. P. perforata**
43. Lower side with black or pale brown center and brown margin.
44. Lower side uniformly brown or pale brown.
45. Lower side rhizinate to the margin.
80. P. subcaperata
45. Lower side naked at the margin . **84. P. aldabrensis**
44. Lower side black at the center.
46. Lower side rugose, short rhizinate to the margin; southern South America . . . **106. P. uruguensis**
46. Lower side smooth, naked at the margin; tropical America and Australia . . . . . **101. P. reparata**
41. Medulla K−.
47. Medulla C+ rose or red.
48. Cortex maculate; medulla C+ rose (gyrophoric acid).
89. P. euneta
48. Cortex dull, emaculate; medulla C+ red (lecanoric acid).
57. P. hololoba
47. Medulla C−.
49. Lower side uniformly pale brown, rhizinate to the margin.
80. P. subcaperata
49. Lower side black at the center, paler at the margins.
50. Cortex dull, emaculate; lower side brown at the margins.
51. Plants saxicolous; exciple ciliate . . **65. P. ornatula**
51. Plants corticolous; exciple eciliate.
61. P. maclayana
50. Cortex shiny, maculate; lower side usually pale ivory to white, brown, or mottled below at the margins.
52. Amphithecium coarsely rugose-lobulate.
91. P. hanningtoniana
52. Amphithecium smooth or rugose.
53. Medulla KC− . . . . . **83. P. abessinica**
53. Medulla KC+ red.
54. Cryptochlorophaeic acid present.
83. P. abessinica
54. Alectoronic acid present.
55. Lower side with a broad white margin.
102. P. rigida
55' Lower side mottled or brown at the margin.
56. Thallus coriaceous; cilia coarse; Asia.
97. P. nilgherrensis
56. Thallus membranous; cilia fine; tropical America . . . . . **86. P. chiapensis**

23. Apothecia not present.
  57. Medulla K−. P−.
    58. Medulla C+ red or rose.
      59. Lobes sublinear, laciniate, emaculate . . **39. P. amboimensis**
      59. Lobes rotund, maculate . . . . . **89. P. euneta**
    58. Medulla C−.
      60. Cortex strongly white-maculate . . . . . **80. P. subcaperata**
      60. Cortex dull, lacking white maculae.
        61. Thallus corticolous, laciniate . . . . . **45. P. corniculans**
        61. Thallus saxicolous, without laciniae . . **44. P. breviciliata**
  57. Medulla P+ and/or K+ yellow to red.
    62. Cortex strongly white-maculate.
      63. White rim below or brown and naked . . . **99. P. perforata**
      63. Brown below with fine rhizines to the margin. **80. P. subcaperata**
    62. Cortex dull, emaculate.
      64. Medulla K+ distinct yellow or red.
        65. Lobes with distinct marginal laciniae; salacinic acid present. **53. P. curysaca**
        65. Lobes with few laciniae; salacinic acid lacking.
          66. Stictic acid present; tropical America and South Africa. **51. P. eciliata**
          66. Unknown substance present; Africa . **59. P. inexspectata**
      64. Medulla K− or K+ faint brownish yellow (protocetraric acid present).
        67. Thallus saxicolous; lobes distinctly ciliate . **43. P. blanchetii**
        67. Thallus corticolous; cilia rare . . . . . **29. P. zollingeri**

Subgenus *Amphigymnia*

Section *Amphigymnia* Vain. (1890, p. 28).

Parmotrema Mass. Atti I. R. Ist. Veneto, III, 5: 248. 1860. Lectotype: *P. perforata* (Jacq.) Ach.

Type species: *Parmelia tinctorum* Nyl.

Thallus adnate to loosely attached, 5–30 cm. in diameter; lobes broad, rotund, 5–20 mm. wide; lower side black or brown, rhizinate in the center, the rhizines simple, often coarse, the margins usually with a broad naked zone; apothecia more or less pedicellate, the disc often perforate.

1. Section *Amphigymnia*

Section *Amphigymnia* * *Subglaucescentes* Vain. (1890, p. 28, as "Subglaucescens").

Section *Subglaucescentes* (Vain.) Gyel. (1932, p. 225).

Section *Subglaucescentes* subsection *Eciliolae* Gyel. (1932, p. 225).

Section *Amphigymnia* subsection *Subglaucescentes* (Vain.) Hillm. (1934, p. 243). Superfluous combination.

Thallus adnate to loosely attached; lobes broad, rotund, 5–20 mm. wide, the margins eciliate or rarely with sparse cilia in the axils; lower side black and rhizinate, the marginal zone brown, ivory to white, or mottled and naked.

The 29 species in section *Amphigymnia* seem to form a natural grouping. Most have a brown rather than white marginal rim below and all except *P. andina, P. austrosinensis,* and *P. disparilis* lack maculae. Five of the eight species in the subgenus with lecanoric acid are found in this section; only one species (*P. pancheri*) contains alectoronic acid. Eleven of the species are endemic to the Americas, five to Asia, and only three to Africa. These facts seem to indicate that section *Amphigymnia* is the most primitive group in the subgenus.

1. **Parmelia andina** Müll. Arg. Rev. Mycol. 1: 169. 1879.
   Parmelia abessinica var. *nuda* Müll. Arg. Flora 62:289. 1879. Type collection: Seriba Ghattas, Djur, Africa, *Schweinfurth* (G, lectotype; M, US, W, isotypes).
   P. africana Müll. Arg. Flora 63:265. 1880. Based on *P. abessinica* var. *nuda* Müll. Arg.
   P. hildebrandtii Kremplh. f. *nuda* Müll. Arg. Flora 74:376. 1891. Type collection: South Africa, *Hannington* (G, lectotype).
   P. zambesica Müll. Arg. Verhl. Zool. Bot. Gesell. Wien 53:296. 1893. Type collection: Boroma, Africa, *Menyhart* s.n. (G, lectotype).
   P. pedicellata Stein. Sitzungsber. Akad. Wiss. Wien 106:214. 1897. Type collection: Matchakos, Kenya, *Liechtenstein,* 1896 (WU, holotype).
   P. olivetorum var. *esorediata* Vain. *in* Welw. Cat. Afr. P1. 2:399. 1901. Type collection: Serra de Mongollo, *Welwitsch* 110 (TUR, lectotype; BM, isotype).
   P. olivetorum var. *hyporysalea* Vain. *in* Welw. Cat. Afr. P1. 2:399. 1901. Type collection: Morro de Lopolla, Angola, *Welwitsch* 27 (TUR, lectotype; BM, isotype).
   P. menyhartii Stein. Verh. Zool. Bot. Gesell. Wien 53:235. 1903. Type collection: Zambesi, Africa, *Menyhart*(?) 475 pr. p. (WU, holotype).
   P. paraguariensis Lynge, Ark. Bot. 13, no. 13:71, *pl. 1, fig. 7.* 1914. Type collection: Cierro Negro, Paraguari, Paraguay, *Malme* 1539 (S, holotype).
   P. rissoensis Lynge, Ark. Bot. 13, no. 13:69. 1914. Type collection: Near Río Apa, Colonia Risso, Paraguay, *Malme* 1895B (S, holotype).
   P. hyporysalea (Vain.) Vain., Bot. Mag. Tokyo 35:47. 1921.
   P. hyporysalea (Vainio) Stein. & Zahlbr. Bot. Jahrb. Engler 60:533. 1926. Superfluous combination.
   P. hyporysalea var. *menyhartii* (Stein.) Stein. & Zahlbr. Bot. Jahrb. Engler 60:535. 1926.
   P. pedicellata var. *subbullata* Stein. & Zahlbr. Bot. Jahrb. Engler 60:536. 1926. Type collection: Bukoba, Lake Victoria, Africa, *Schröder* 323 (W, holotype).
   P. dalei Dodge, Ann. Mo. Bot. Gard. 46:131. 1959. Type collection: Toro, Fort Portal, Uganda, *Dale* L44 (K, holotype).
   P. subbullata (Stein. & Zahlbr.) Dodge, Ann. Mo. Bot. Gard. 46:162. 1959.
   P. thomasii Dodge, Ann. Mo. Bot. Gard. 46:168. 1959. Type collection: Mt. Otse, West Nile, Uganda, *Thomas* 1962 (K, holotype).

Type collection: Cisne, Ecuador, *André* 4324 bis (G, holotype; K, isotype).

Thallus often very large, to 30 cm. broad, loosely attached to bark, light mineral gray; lobes large and rotund, 10–20 mm. wide, margins

smooth to broadly crenate, cilia lacking; upper surface plane to broadly undulous, continuous or reticulately cracked with age, faintly to distinctly white-maculate, isidia and soredia lacking; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia numerous, large, to 20 mm. in diameter, stalked, amphithecium rugose, white-maculate, disc perforate; hymenium 50–70 μ high; spores 7–10×13–18 μ, the episporium 1.0–1.5 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ blood red, P−, atranorine and lecanoric acid present.

The large synonymy of *P. andina* seems unaccountable. It is a conspicuous, extremely uniform lichen with a combination of morphological and chemical characters quite unique in the subgenus *Amphigymnia*. Large perforate apothecia are almost always present in great abundance. The maculae are usually distinct but may be rather faint on older lobes. It is most common in savannas of central and south-central Africa as far south as the Tropic of Capricorn but completely absent from the Cape area. It is much rarer in other tropical areas in South America and Asia (fig. 5). The sorediate counterpart is *P. austrosinensis* Zahlbr.

Additional specimens examined:

COLOMBIA: No locality, *Blaghorne*, s.d. (K). BOLIVIA: Chaco: Fataranda, *Fries* L156 (S). PARAGUAY: Paraguari, *Malme* 1529 (MO). ARGENTINA: Salta: General Ballivián, Orán, *Digilio-Grassi* 676 (MO).

SUDAN: Mongalla, *Dandy* 523 (BM). IVORY COAST: Cercle Dombokro: Mt. Orombo-Boka, *Santesson* 10724a (UPS). LIBERIA: Central Province: Piatah, Gbarnga, *Baldwin* 12383 (US). GUINEA: Cercle of N'Zérékoré: Nimba Mtns., *Santesson* 10516b (UPS). SIERRA LEONE: Njala, *Deighton* M5976 (K). CAMEROONS: Between Jaunde and Dengdeng, *Mildbraed* 8403 (K). ANGOLA: Benzuela: Between Benzuela and Coporolo, *Degelius*, Feb. 2, 1960 (DEGEL); Bié: Chinguar, *Degelius*, Feb. 9, 1960 (DEGEL); between Vila General Machado and Coemba, *Degelius*, Feb. 10, 1960 (DEGEL); Cuanza Sul: Near Santa Comba Dao, *Degelius*, Mar. 3, 1960 (DEGEL); Capir, Amboim, *Gossweiler* 9907 (BM); Huila: Bimba, Humpala Plateau, *Degelius*, Feb. 6, 1960 (DEGEL); Malange: Northeast of Lunda, Dundo, *Gossweiler* 13928 (US); Moxico: Luso, *Degelius*, Feb. 11, 1960 (DEGEL). REPUBLIC OF CONGO: Brazzaville, *Degelius*, Mar. 12, 1960 (DEGEL). CONGO: N. Kivu: Nyarusambo, Goma, *Degelius*, Mar. 16, 1960 (DEGEL). RUANDA-URUNDI: Usumbara, *Degelius*, Mar. 17, 1960 (DEGEL); west of Albertville, *Höeg*, Feb. 25, 1930 (TRH, US); Patambalu, *Tailfer* 43 (BR); Kiyaka-Kwango, *Devred* 2607 (BR); near Lukafu, *Schmitz* 1839 (BR); Eala, *Louis* 2123 (BR). NORTHERN RHODESIA: Abercorn Distr., *Bullock* 2103 pars (K). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Mar. 4, 1930 (TRH); Makoni, *Eyles* 215 (PRE); Salisbury, *Montagu* 1809 (PRE); Dora River, Umtali, *Schweickerdt* 2219 (PRE). KENYA: Central Prov.: Nairobi, *Maas Geesteranus* 10273 (L, LD); 4 mi. W. of Nairobi, *Maas Geesteranus* 4393 (L, LD). TANGANYIKA: Dodoma, *Höeg*, Mar. 16, 1930 (TRH); Kigonsero, at Peramiho, *Detrich*, 1958 (KLEM). UGANDA: Budonga Forest, Bungoro, *Taylor* 3319 (BM); Kilpayo, *Dümmer* 848 (BM);

West Nile, below Metu Rest Camp, *Chancellor*, Sept. 14, 1953 (BM). MOÇAMBIQUE: Catembe, Lorenço Marques, *Borle* 35 (PRE). UNION OF SOUTH AFRICA: NATAL: Weenin, *Höeg*, Oct. 20, 1929 (TRH); Pinetown, *Doidge* 1546 (PRE).

MADAGASCAR: Côte de Mahafaly, *Perrier de la Bathie*, June 1910 (LD). INDIA: Madras, *Shuter*, s.d. (K); MADURAI DISTR.: Shembaganur, *Foreau* 4176 (AWAS). THAILAND: Doi Sutep, *Tsuyama* 10, 11 (TNS). TAHITI: *Wragge*, December 1905 (BM).

2. Parmelia araucariarum Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:179. 1909.

Type collection: Near São Amaro, São Paulo, Brazil, *Schiffner* (W, holotype; BPI, MICH, isotypes).

Thallus often large, 10–15 cm. in diameter, loosely attached to bark, mineral gray with a yellowish tinge at times; lobes rotund, 7–14 mm. wide, becoming crowded and suberect toward the center, margins entire, sorediate, soralia linear to irregular, sorediate lobes sinuate and dissected, soredia granular; upper surface shiny, continuous to reticulately cracked with age; medulla pale yellow orange; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K+, C+, KC+ more intensely yellow, P−, atranorine, an unidentified pigment, and unknown substances present.

Externally *P. araucariarum* closely resembles *P. dilatata* Vain., but the medulla is pigmented orange yellow and the lobe margins are not as dissected. It is apparently the sorediate phase of *P. myelochroa* Hale, although the chemicals accompanying the unknown pigment have not yet been fully determined for either species. *Parmelia araucariarum* is endemic and widespread in South America.

Additional specimens examined:

BRITISH GUIANA: Essequibo River, Moraballi Creek, *Richards* 239 (K). PERU: SAN MARTÍN: Tingo María, elev. 625–1100 m., *Allard* 20700, 21893, 22524 (US); HUÁNUCO: Hacienda Exito, Churubamba, *Mexia* 8249a (F, US); AYACUCHO: Aina, between Huanta and Río Apurimac, *Killip & Smith* 23142 (US). BRAZIL: No locality, *Gardner* (M). PARAGUAY: Villa Morro, Asuncion, *Malme* 1585 (S). ARGENTINA: SALTA: Río Pescado, *Digilio-Grassi* 384, 469 (MO).

3. Parmelia austrosinensis Zahlbr. Symb. Sin. 3:192. 1930.

Parmelia olivetorum var. *hypomelaena* Krempelh. Verh. Zool. Bot. Ver. Wien 26:443. 1876. Type collection: Lima, Peru, *Barranca* (M, holotype; UPS, isotype).

P. olivetorum var. *sorediosa* Vainio *in* Welw. Cat. Afr. Pl. 2:399. 1901. Type collection: Serra de Muxaûla, Cazengo, Angola, *Welwitsch* 112 (TUR, holotype; BM, isotype).

P. hyporysalea (Vainio) Vainio var. *cinerascens* Vainio, Bot. Mag. Tokyo 35:47. 1921. Type collection: Prov. Awaji, Japan, *Mikuma* 140 pr. p. (TUR, Vain. herb. no. 2564, holotype).

P. mesotropa var. *compactior* Zahlbr. Symb. Sin. 3:192. 1930. Type collection: Sanyingpan, north of Yunnanfu, Yunnan, China, *Handel-Mazzetti* 581 (WU, holotype; W, isotype).

P. meridionalis Tavares, Port. Acta Biol., ser. B, 1:159, *pl. 10, fig. 2.* 1945. Type collection: Arredores de Setúbal, Estremadura, Portugal, *Tavares* (LISU, holotype; not seen); Portela de Sacavém, Estremadura, Portugal, *Tavares* (M, paratype).

P. cazengensis Dodge, Ann. Mo. Bot. Gard. 46:152. 1959. Based on *P. olivetorum* var. *sorediosa* Vainio.

P. olivetoroides Dodge, Ann. Mo. Bot. Gard. 46:154. 1959. Type collection: Cape of Good Hope, s.c. (FH–Tuck, holotype).

Type collection: Gwanyinschan, near Kweiyang, Kweitschou, China, *Handel-Mazzetti* 10580 (WU, lectotype; BPI, W, isotypes; cf. Hale (1959a) for details of typification).

Thallus 6–10 cm. in diameter, loosely attached to bark, very light mineral gray; lobes broad, 10–15 mm. wide, often ascending, rotund, margins sorediate, sinuate, soralia linear; upper surface plane, dull to shiny and more or less clearly maculate; lower side black and rhizinate at the center, naked and light brown, mottled to ivory, or white in a broad zone along the margins. Apothecia very rare, substipitate, to 10 mm. in diameter, amphithecium maculate, sparsely sorediate, disc widely perforate; hymenium 75 μ high; spores 6–10×10–16 μ, episporium 1.5 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ blood red, P−, atranorine and lecanoric acid present.

Parmelia austrosinensis is the sorediate counterpart of *P. andina* Müll. Arg. It is a pantropical species most common in savannas of Africa and southern South America (fig. 6). When typically developed, the thallus is medium sized, suberect, with strictly marginal soralia and a distinct white zone below. Maculae range from quite distinct to virtually absent. Apothecia are extremely rare.

Additional specimens examined:

U.S.: Missouri: Kirbyville, Taney Co., *Hale* 4400 (US); Louisiana: New Orleans, Orleans Co., *Tainturier* s.n. (US); Texas: East of Fort Worth, Tarrant Co., *Stretilzer* s.n. (WISC); 18 m. east of San Antonio, Bexar Co., *Hubricht* B1926 (MO); Pearsall, Frio Co., *Darrow* 4864 (DUKE); Duffau, Erath Co., *Hale* 5494 (US); 10 mi. west of Leakey, Real Co., *Darrow* 4901 (US). MEXICO: San Luis Potosí: Del Maiz, *Cain* 27608 (TRTC, US); Guanajuato: South of San Luis de la Paz, *Cain* 27562a (TRTC, US); Puebla: 69 km. east of Puebla, *Hale* 19336 (US); Paseo Viejo, *Arsène* 4197 (US); Veracruz: 9 km. east of Jalapa, *Hale* 19412 (US); Oaxaca: 53 km. northwest of Oaxaca, *Hale* 20801 (US); Chiapas: South of Teopisca, *Hale* 20508 (US).

HAITI: Below Furcy, Dept. de l'Ouest, *Wetmore* 2678 (MSC, US). DOMINICAN REPUBLIC: Gauma, Santiago, *Wetmore* 3911 (MSC, US); Los Amaceyes, Cordillera Setentrional, *Wetmore* 3392 (MSC).

VENEZUELA: Lara: Barquisimeta, *Saer* 2, 135 (US). COLOMBIA: Chipaque, *André* 1226 (K). URUGUAY: Parque Rivera, Montevideo, *Herter* 99689

(MO, US). ARGENTINA: Pampa del Infierno, *Meyer* 2106 (MO); no locality, *Lorentz & Hieronymus* (M).

ETHIOPIA: Addis Ababa, *Negri* s.n. (F). CONGO: Yangambi, Lueveo Plateau, *Louis* 8155 (BR); Kiyaka-Kwango, *Devred* 2607 (BR). KENYA: Naivasha Prov.: Kinangop, Aberdare Mountains, *Taylor* 1616 (BM); Central Prov.: 5 km. west of Nairobi, *Maas Geesteranus* 10271 (L, LD); Rift Valley Prov.: Menengai, Nakuru Distr., *Maas Geesteranus* 4610, 10281 (L, LD, US), 4556, 4621, 4622 (L). MOÇAMBIQUE: Lourenço Marques: 2 km. east of Namaacha, *Almborn* 7106 (LD); 3 km. north of Vilahuiza, *Almborn* 6884 (LD); Lourenço Marques, *Junoa* 474 (PRE). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH); Gwelo, *Höeg*, Jan. 2, 1930 (TRH). UNION OF SOUTH AFRICA: Orange Free State: Clarens, *Plank* s.n. (PRE); Transvaal: Pretoria, *Smith* 6274 (PRE), *Almborn* 5878 (LD); Sibasa, *Reusburg* 1573 (PRE); Bushbuckridge, *Wager* 1386 (PRE); Basutoland: Near Masite Mountains, *Hewitt* s.n. (TRH); Natal; Boschfontein Forest, Lions River Distr., *Almborn* 8724 (LD); 4 mi. south of Pietermaritzburg, *Almborn* 8541 (LD); Weinen, *Höeg*, Oct. 20, 1929 (TRH); northeast of Eschowe, Eschowe Distr., *Höeg*, Sept. 8, 1929 (TRH); Upper Umkomaas, Impendhle, *Höeg*, Oct. 3, 1929 (TRH); Innersdale, Estcourt, *Höeg*, Nov. 3, 1929 (TRH); north of Hluklurve, Nongoma, Zululand, *Höeg*, Aug. 17, 1929 (TRH); Cape Province: Koningskroon Farm, Elliot, *Höeg*, Dec. 1, 1929 (TRH); Port Alfred, *Höeg*, Dec. 16, 1926 (TRH); Woodbury, Alexandria, *Höeg*, Aug. 20, 1929 (TRH); Dordrecht, *Höeg*, Nov. 21, 1929 (TRH); Port Elizabeth, *Höeg*, August 1929 (TRH); Round House, Lions Head Distr., *Arnell* 1146c (LD); Oudtohoorn, Congo Caves, *Arnell* 1450a (LD); Wilderness, George, *Arnell* 1344b (LD); Kentani, *Pegler* 1231 (PRE); Kingwilliamstown, *Victoria* 33 (PRE); Erste River, Stellenbosch, *Garside* 100, 148 (BM); 13 mi. east of East London, *Almborn* 10666 (LD); east of Kirstenbosch, Wynberg Distr., *Almborn* 23 (LD); Grahamstown, Albany Distr., *Britton* s.n. (TRH), *Almborn* 10861 (LD); near Coega, Uitenhage, *Almborn* 4065, 4107 (LD).

INDIA: Above village Naret, Askote, Almora, Northwest Himalayas, *Awasthi* 3297 (AWAS). JAPAN: Prov. Totomi: Kawasaki, *Kurokawa* 51074 (LD, TNS, US). SUMATRA: Sitarang, Toba, *Ouwehand* 175 (BO); Karshoogvlakte, *Lörzing* 7052 (BO). JAVA: Tjiumbuleuit, near Bandung, *Groenhart* 8855, 8867 (BO); Pasir Larongé, *Lugard* 10 (BO); Tjibodas, *Neervoort* 65 p.p. (BO); Tjipanas, *Lugard* 18 (BO). AUSTRALIA: Queensland: Brisbane, *Bailey* s.n. (BM).

4. Parmelia crassescens Stirton, Royal Phil. Soc. Glasgow Proc. 10:161. 1877.

Type collection: Amazonas, South America, *Trail* 17 (BM, holotype; GLAM, isotype).

Thallus loosely adnate, 10–15 cm. wide, light mineral gray, turning buff in the herbarium; lobes rotund, 7–12 mm. wide, more or less convoluted in age, margins crenate to irregularly lobulate, soredia, isidia, and cilia lacking; upper surface dull, continuous but becoming rugose and reticulately cracked with age; lower side black and sparsely rhizinate at the center, brown and naked in a broad zone at the margins. Apothecia more or less adnate, 3–5 mm. in diameter, disc imperforate; hymenium 80–90 μ high; spores 10–12$\times$20–25 μ, episporium 1.5–2.0 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ yellow orange, atranorine and norstictic acid present.

The type of *P. crassescens* is a fragment which at first seemed to be identical with *P. latissima* Fée. It is chemically distinct from *P. latissima,* however, in producing norstictic acid, a rare acid in subgenus *Amphigymnia.* Two fertile collections from South America have consistently smaller spores than *P. latissima.*

Additional specimens examined:

BRITISH GUIANA: Basin of Rupununi River, Yupukari, *Smith* 2256 (K, MO, US). BRAZIL: Serra do Itatiaia, *Hemmendorff* 12 (S).

5. Parmelia cristifera Tayl. London Journ. Bot. 6:165. 1847. PLATES 1, 4

Parmelia perforata var. *ulophylla* Mey. & Flot. Nov. Act. Acad. Caes.-Leop.-Carol. Naturf. 19, suppl. 1: 218. 1843. Type collection: Oahu, Hawaiian Islands (G, lectotype).

P. hildebrandtii Kremplh. Linnaea 41:139. 1877. Type collection: Johanna Island, Comoro Islands, *Hildebrandt* 1866c (BM, K, isotypes).

P. hildebrandtii f. *sorediosa* Müll. Arg. Flora 74:376. 1891. Type collection: Comoro Island, *Schweinfurth* s.n. (G, lectotype; K, isotype).

P. mesotropa Müll. Arg. f. *sorediosa* Müll. Arg. Flora 74:377. 1891. Type collection: Cachar, India, *Keenan* (K, holotype; G, isotype).

P. latissima Fée f. *cristifera* (Tayl.) Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:205. 1899.

P. claudelii var. *clemensiae* Vain., Phil. Journ. Sci. 4:659. 1909. Type collection: Lake Lanao, Mindanao, Philippines, *Clemens* 1319 (TUR, Vain. herb. no. 2542, lectotype).

P. submesotropa Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. mesotropa* f. *sorediosa* Müll. Arg.

P. cristifera f. *cinerata* Zahlbr. Repert. Sp. Nov. Fedde 33:58. 1934. Type collection: Kuwarus, Formosa, *Asahina* 51 (W, holotype; BPI, isotype).

P. gardneri Dodge, Ann. Mo. Bot. Gard. 46:179. 1959. Type collection: Brazil, *G. Gardner* (FH-Tayl, holotype).

P. gossweileri Dodge, Ann. Mo. Bot. Gard. 46:153. 1959. Type collection: Chiloango, Angola, *Gossweiler* 8091 (K, holotype).

P. imerinensis Dodge, Ann. Mo. Bot. Gard. 46:143. 1959. Type collection: East Imerina, Madagascar, *Hildebrandt* (FH, holotype).

Type collection: Calcutta, India, *Wallich* (FH-Tayl, lectotype).

Thallus expanded, 10–25 cm. in diameter, loosely attached to bark, light mineral gray; lobes broad and rotund, 12–20 mm. wide, margins sorediate, soralia linear, sorediate lobes sinuous, more or less involute, cilia lacking; upper surface dull, continuous, cracked with age; lower side black and sparsely rhizinate, naked and brown in a broad zone along the margins. Apothecia rare, usually poorly developed, adnate, 1–5 mm. in diameter, disc imperforate; hymenium 100–120 μ high; spores 13–18×26–35 μ; episporium 3–4 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C—, KC—, P+ orange red, atranorine and salacinic acid present.

Parmelia cristifera is one of the commonest pantropical Parmelias, collected frequently by all botanists. It is characterized by abundant

marginal soralia and salacinic acid. Apothecia are very rare; spores are large, indicating a close affinity with *P. latissima* Fée, which is strictly tropical and primarily American. *Parmelia cristifera* is especially common in tropical America and the Pacific region (cf. fig. 4), but it is surprisingly rare in Africa and unknown from all of eastern Africa. The only species with which *P. cristifera* might be easily confused is *P. dilatata* Vain., which differs in containing protocetraric acid (medulla K—), in having sparse development of cilia, and in more laciniate margins with coarse irregular soralia.

Müller based *P. hildebrandtii* f. *sorediosa* on five syntypes from Africa, but only the one listed above was found at Geneva. The type collections of *P. perforata* var. *ulophylla* Mey. & Flot. were destroyed at Berlin, but fortunately Hillmann (1940) had examined the material. It consisted of a mixture of *P. cetrata* Ach. and *P. cristifera* Tayl. The isotype at Geneva is a mixture of the same two species, of which *P. cristifera* is selected as the lectotype.

Additional specimens examined:

U.S.: Florida: Suwanee River State Park, Suwanee Co., *Hale* 17573 (US); 5 mi. north of Okeechobee, Okeechobee Co., *Hale* 17723 (US); 5 mi. north of Silver Glen Springs, Marion Co., *Hale* 17591 (US); Sanford, Seminole Co., *Rapp, Merrill, Lich. Exs.* 54 (FH, US); Highlands Hammock State Park, Highlands Co., *Hale* 16923 (US); 12 mi. west of Daytona Beach, Volusia Co., *Hale* 17083 (US); Lakeland, Polk Co., *McFarlin* 230 (FLAS); Hillsborough State Park, Hillsborough Co., *Schallert* s.n. (FLAS). MEXICO: Jalisco: Santa Cruz de Vallarta, *Mexia* 1299 (US); Hidalgo: Cuyamaloya, *Pringle* 10753 (US); Vera Cruz: 15 mi. south of Catemaco, *Hale* 19846, (US); 46 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19463 (REN, US), 19456 (MSC, US); Puebla: Cholula, *Arsène* 4297 (US); Chiapas: El. Suspiro, 10 km. north of Berriozábal, *Hale* 20220 (US); El Sumidero, near Tuxtla Gutiérrez, *Hale* 20073 (S, TNS, US); Hacienda, *Matuda* s.n. (MICH). BRITISH HONDURAS: Bermuda Bank, *Lundell* 1981 (MICH). NICARAGUA: Mosquito Coast, *Schramm* s.n. (US); Sangsangta Distr., *Schramm* 50 (US). COSTA RICA: Hamburg Finca, below Cairo, Prov. Limón, *Standley* 48670 (US); San Isidro Coronado, *Alfaro* 32398 (US). PANAMA: Canal Zone: Juan Mina, Chagres River, *Bartlett* 16822 (MICH); Las Cascadas Plantation, near Summit, *Standley* 29500 (US).

BAHAMAS: Great Bahama, *Brace* 3608 (NY); New Providence, *Britton* 3311 (NY); Maidenhead Coppice, *Britton* 3233, 3238 (NY). CUBA: No locality, *Wright, Lich. Cubae* 68 (K, UPS, US); Pinar del Rio, *Cuesta* 395 (NY); Baracoa, *Johnston* s.n. (FH); near Santa Barbara, Isle of Pines, *Ross* s.n. (F); La Prenda, *Manuel* 36a, *Hioram* 5226 (BPI); Loma del Gato, Sierra Maestra, *León* 10614 (BPI, NY); Puerto Boniato Ridge, Santiago de Cuba, Oriente, *Imshaug* 24652 (MSC, US). HAITI: St. Michel de l'Atalaye, *Leonard* 7857 (NY); near Kalacroix, Dept. Artibonite, *Leonard* 7837 (US); northwest of Jacmel, *Thomas* 75 (MO), 77 (NY, US); below Citadelle, south of Milot, *Wetmore* 2838 (MSC). DOMINICAN REPUBLIC: Sabana de la Rosa, near Km. 28, on Durante highway, *Allard* 15982b, 15994 (US); Piedra Blanca, La Vega, *Allard* 18025 (US); Hato Major, Siboey, *Thomas* 53, (FH, MO, NY); Consuelo, Macoris, *Taylor* 126 (FH,

NY); without locality, *Raunkiaer* 497 (C). JAMAICA: Without locality, *Hansen* (C); Mandeville, *Cushman* 11, 147 (FH); Westmoreland Hills, New Market, *Britton* 524 (FH, NY); Farm Hill, St. Thomas, *Orcutt* 3551 (US); near Castleton, *Maxon* 737 (US); Strawberry Hill, Cinchona, *Plitt* 46 (BPI); Fern Gully, St. Ann, *Imshaug* 15796 (MSC, US); Lime Hall to Green Park, St. Ann, *Imshaug* 15849 (MSC, US); Mt. Diablo, St. Catherine, *Imshaug* 13766, 13767 (MSC); Wareika House, summit of Long Mountain, *Imshaug* 13499 (MSC). PUERTO RICO: Barranquitas, *Hioram* 220, 221 (NY, FH), *Sintenis* 43 (G); near Cayey, *Sintenis* 27, 29 (G); near Adjuntas, *Sintenis* 77, 79, 110a (G), 96 (G, K); Mayaguez, *Fink* 1282 (FH, M, MICH); Naranjito, *Fink* 273 (FH, MICH); Aibonito, *Fink* 1837 (FH, MICH); 7 miles south of Caguas, *Heller* 295, 309 (FH, NY); Monte Llano, Cayey, *Goll* 460 (US); Caguitas, *Goll* 361 (US); Arecibo to Utuado, *Howe* 385 (NY); Mt. Morales, near Utuado, *Howe* 440 (FH, NY); Rio de Maricao, *Britton* 4057 (FH, NY); Vega Baja, *Britton* 1435 (FH, NY); San Narciso, *Britton* 7332 (NY); Monte Montoso, *Britton* 4152, 4173 (FH, NY); Luquillo Mountains, *Wilson* 55 (FH, NY), 295 (NY); Campo Alegre, *Stevenson* 2477 (FH, US). VIRGIN ISLANDS: Virgin Gorda, Virgin Peak, *Smith* 10575 (US); St. Croix: Mt. Eagle, *Boergesen* s.n. (C), *Thompson* 462 (NY); St. Thomas: Crown, *Britton* 1441 (FH, NY); without locality, *Eggers* s.n. (C). GUADELOUPE: Without locality, *Questel* 3810 (MO), *L'Herminier* s.n. (UPS); Prise d'Eau, *LeGallo* 2724 (MSC); near Lamentin, *LeGallo* 583 (MO); Vernon, Basse-Terre, *Degelius*, June 23, 1958 (DEGEL). DOMINICA: Roseau, *Evans* 64 (FH, NY, YU). MARTINIQUE: Le Morne Rouge, *Degelius*, May 20, 1958 (DEGEL); Ajoupa-Bouillon, *Degelius*, May 25, 1958 (DEGEL). GRENADA: Epping Forest, St. David, *Imshaug* 16146 (MSC, US).

SURINAM: Without locality, s.c. (K). BRITISH GUIANA: Pl. Vryheid, *Linder* 949 (MICH); near Kaieteur Falls, *Cowan & Soderstrom* 2041 (US); along Mure-mure Creek, Kaieteur Plateau, *Cowan & Soderstrom* 2203 (US). VENEZUELA: Between Cotiza and Las Venados, near Caracas, *Allert* 78 (US); Bolívar: Guaiquinima, Río Paragua, *Killip* 37845 (US). COLOMBIA: Dept. Santander: Northern slope of Mesa de los Santos, *Killip & Smith* 14996 (US). PERU: Dept. San Martín: Tingo María, *Allard* 20562 (US); Dept. Ayacucho: Aina, between Huanta and Río Apurimac, *Killip & Smith* 22572: (US). BRAZIL: Near Santos, São Paulo, *Schiffner* s.n. (M).

GUINEA: Issia, cercle of Dalva, *Santesson* 10400a (UPS). IVORY COAST: 20 km. west of Séguéla, *Santesson* 10673b (UPS). LIBERIA: 10 miles east of Zwedru, Tchien Distr., *Baldwin* 12412 (US). NIGERIA: Nkami Road, Oban, *Talbot* s.n. (BM). CONGO: Eala, *Guesquière* 2081 (BR, US); Yangambi, Luweo Plateau, *Louis* 7150 (BR). ANGOLA: Buco Zau, Cabinda, *Gossweiler* 7240 (BM); Sera Subluali, Maiambe, *Gossweiler* 8033 (BM). MAURITIUS: *Robillard* s.n. (M, US). BOURBON: *Rodriguez* 8, 21 (P).

BURMA: Without locality, *McMillan* 279 (US). THAILAND: Udaun, *Kerr* 215 (K); Chieng Dao, *Tsuyama* 4 (TNS, US); Neeckey, *Kostermans* 532 (BO). FORMOSA: Taroko, *Ogata* s.n. (TNS, US). PHILIPPINES: Bohol, *Ramos* 11585 (F); Tayabas: Lucban, Luzon, *Elmer* 7227 (US); Rizal: Luzon, *Ramos* 22477 (US). SUMATRA: Near Lubuk Sikaping, Tandjung Alai, *Groenhart* 8991 (BO); Boekit Koelampi, *Theunissen* s.n. (BO); Fort de Kock, *Jacobson* 10 (BO). SARAWAK: Kuching, *Brooke* 462 (BM). BORNEO: Peak of B. Papan, Kutai, *Meijer* B2045 (BO). CELEBES: Rante Lemo, *Kjellberg* 33 (BO). AMBON ISLAND: Laha, *Ruinen* s.n. (BO). NEW GUINEA: Nondugl, Western Highlands Distr., *Hoogland* 3194 (BM).

FIJI: Viti Levu: Mba, vicinity of Nandarivatu, *Smith* 5968 (US). MARQUESAS ISLANDS: Nukuhiva, near Hakaui, *Brown* 472 (BISH). RAROTONGA: *Parks* 22396 (F). PITCAIRN ISLAND: Parlver Valley Ridge, *St. John* 14963 (BISH). HAWAIIAN ISLANDS: Maui: Honokahau Drainage Basin, *Forbes* 587 (BISH); Kauai: *Faurie* 74, 75, 76, 77, 84 (BM); Hawaii: Milo, *Faurie* 853, 854 (BM); Oahu: Honolulu, *Faurie* 448 (BM); Pohakea Pass, Waianae Mountains, *Fosberg* 9510 (US); Kalimoa Valley, *Rock* 86 (US); Tantalus, *Heller* 2160 (US); without locality, *Heller, Merrill Lich. Exs.* 200 (M, US). NEW ZEALAND: Without locality, *Banks & Solander*, August 1769 (BM).

6. Parmelia crocoides Hale, sp. nov.

Thallus laxe adnatus, 6–12 cm. diametro, cinereo-glaucescens, lobis rotundatis, 8–14 mm. latis, margine integris vel aetate incisis, superne planus, nitidus, levissime albomaculatus, aetate rugosus, rimosus, sorediis, isidiis, ciliis destitutis, strato corticeo superiore 10–13 μ crasso, strato gonidiali 16–20 μ crasso, medulla croceo-lutea, 110–130 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu fusco-castaneus, late nudus. Apothecia ignota; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+, C+, KC+ intensius croceo-lutea, P−, atranorinum, acidum protolichestericum, et pigmentum K− ignotum continens.

Type in the U.S. National Herbarium, collected between San Pedro de Montes de Oca and Curridabat, San José, Costa Rica, Feb. 2, 1924, by P. C. Standley (no. 32772).

This peculiar species appeared at first to be a relative of *P. latissima* Fée but the upper surface is shiny and more or less maculate and the medulla is pigmented pale orange red. Protolichesteric acid is present in low concentration. This species is known only from the type locality.

7. Parmelia defecta Hale, sp. nov.

Thallus adnatus vel laxe adnatus, rigidulus, plerumque saxicola, 6–12 cm. diametro, albicans, parum lobatus, lobis rotundatis, sinuatis, plus minusve congestis ad centrum, superficie et partim margine sorediatis vel pustulato-sorediatis, sorediis diffusis, granulosis, soraliis marginalibus irregulariter linearibus, superne opacus, laevigatus, strato corticeo superiore 14–18 μ crasso, strato gonidiali 16–20 μ crasso, medulla alba, 70–90 μ crassa, strato corticeo inferiore 12–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus vel albo-variegatus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C+ rubescens, KC+ rubescens, P−, atranorinum et acidum lecanoricum continens.

Type in Lund University, collected in Indumeni Forest, Cathedral Park area, Bergville, Natal, Africa, Nov. 3, 1953, by Ove Almborn (no. 8934).

This species appears to be the sorediate counterpart of *P. soyauxii* Müll. Arg. Both species are saxicolous and endemic to Africa.

Parmelia austrosinensis Zahlbr., normally a corticolous lichen, differs in broader, more or less suberect lobes with a pale zone below. These two sorediate species may intergrade to some extent but careful field studies would be needed to clarify their relationship.

Additional specimens examined:

UGANDA: Entebbe, *Proctor*, Mar. 9, 1959 (K, US). SWAZILAND: 15 mi. southwest of Piggs Peak, Mbabane, *Almborn* 7927 (LD). UNION OF SOUTH AFRICA: ORANGE FREE STATE: 5 mi. west of Ladybrand, *Maas Geesteranus* 6521 (L); NATAL: Indumeni Forest, Bergville, *Almborn* 9319 (LD); CAPE PROV.: Dordrecht, *Höeg*, Nov. 21, 1929 (TRH); near the Punch Bowl, Louis Trichardt, Zoutpansberg, *Almborn* 6095 (LD). MADAGASCAR: Montasoa, *Räsänen* (H).

8. Parmelia dilatata Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:33. 1890.

Parmelia cetrarioides f. *integra* Harm. Ann. Crypt. Exot. 1:327. 1928. Type collection: Botanical Garden, Singapore, *Demange* s.n. (P, holotype).

P. robusta Degel. Göteb. Kungl. Vet. Vitterh. Samh. Handl., ser. B, 1, no. 7:33. 1941. Type collection: Forêt de Crannou, Finistère, France, *Picquenard* in 1898 (P, holotype).

P. kauaiensis Zahlbr. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:99. 1944. Type collection: Halemanu to Kaholuamano, Kauai, Hawaii, *Kusche* 5506 (BPI, holotype; W, isotype).

P. lobulascens var. *isidiosissima* Dodge, Ann. Mo. Bot. Gard. 40:375. 1953. Type collection: Gbense, Sefadu, Sierra Leone, *Adames* (K, holotype).

P. sieberi Dodge, Ann. Mo. Bot. Gard. 46:148. 1959. Type collection: Mauritius, *Sieber* 44 (FH, holotype).

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 397 (TUR, holotype, Vain. herb. no. 2548; BM, FH, M, UPS, isotypes).

Thallus loosely attached to bark, 10–20 cm. broad, mineral gray or faintly yellowish gray; lobes rotund, 10–15 mm. wide, margins entire at the tips, laterally becoming lacerate, sorediate, soredia coarse, mostly in linear soralia or developing on short irregular laciniae, cilia lacking or abnormally developed in the axils, 0.5–1.5 mm. long; upper surface smooth, rather shiny, faintly white-maculate or dull, reticulately cracked with age; lower side black and sparsely rhizinate, brown to mottled ivory and naked in a broad zone at the margins. Apothecia rare, 3–5 mm. in diameter, adnate, disc imperforate; hymenium 70–80 μ high; spores 8–10×18–22 μ, episporium about 2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine, protocetraric acid, and rarely traces of usnic acid present.

Parmelia dilatata is one of the commonest pantropical lichens. It is unfortunate that the oldest epithet, *P. dilatata*, is represented only by a single apparently abnormal collection from Rio de Janeiro, which contains a trace of usnic acid and is eciliate. The population lacking usnic acid and having at least some sparse cilia is represented

perfectly by the holotype of *P. robusta* and is by far the commoner phase of this species. Development of cilia is especially variable. Specimens from the West Indies in particular may have conspicuous cilia in the lobe axils and very rarely at lobe tips. Cilia may be so abundant that confusion with *P. subarnoldii* des Abb. is not unlikely. However, *P. subarnoldii* has distinct cilia around the lobe tips as well as finer soredia and more regular, linear soralia. The soralia of *P. dilatata* are typically irregular and produced on small marginal laciniae. Possible points of confusion with *P. cristifera* Tayl. and *P. fasciculata* Vain. are discussed under these species.

Additional specimens examined:

U.S.: TENNESSEE: Cross Roads, Overton Co., *Phillips* 334 (US); SOUTH CAROLINA: Santee State Park, Orangeburg Co., *Hale* 16485 (US); 10 mi. southwest of Walterboro, Colleton Co., *Hale* 16574 (US); GEORGIA: 5 mi. south of Quitman, Brooks Co., *Hale* 16765 (US); 10 mi. northeast of Midway, Bryan Co., *Hale* 16806 (US); FLORIDA: 1 mi. south of Pittman, Lake Co., *Hale* 17750 (US); 26 mi. west of Tallahassee, Leon Co., *Pursell* 100LF30 (MSC); Sebring, Highlands Co., *McFarlin* 566 (FLAS); Bartow, Polk Co., *McFarlin* 96 (FLAS); Tomoka State Park, Volusia Co., *Hale* 17054 (US); Myakka River State Park, Sarasota Co., *Hale* 16911 (US); Fort Myers, Lee Co., *Standley* 326 (US); Sanford, Seminole Co., *Rapp* s.n. (FLAS); 3 mi. west of Bunnell, Flagler Co., *Hale* 17039 (US); Oleno State Park, Alachua Co., *Hale* 16431 (US). MEXICO: VERACRUZ: 11 km. east of Las Vigas, *Hale* 20951 (DUKE, MSC, REN, S, TNS, US); CHIAPAS: Just south of Teopisca, *Hale* 20522 (COLO, DUKE, LISU, MSC, REN, S, TNS, US); Km. 1145 on highway 190, west of San Cristóbal, *Hale* 20202 (COLO, US); 18 km. southeast of San Cristóbal, *Hale* 20274 (US), 20250 (LISU, US); Lagos de Monte Bello, *Hale* 20413 (COLO, US); Mt. Ovando, *Matuda* 28 (TNS). GUATEMALA: ALTA VERAPAZ: Cobán, *Standley* 92061 (MO); Finca Mocca, *Johnson* 170i (US). HONDURAS: COMAYAGUA: Vicinity of Siguatepeque, *Standley & Chacón* P6315 (F); MORAZÁN: La Montañita, *Standley* 12366 (F); EL PARAÍSO: Region of Quebrada de Dantos, *Standley et al.* 1273 (F). BRITISH HONDURAS: El Cayo Distr., *Mains* 4098 (FH, MICH). NICARAGUA: JINOTEGA: Vicinity of Jinotega, *Standley* 9704 (F). COSTA RICA: SAN JOSÉ: Vicinity of Santa Maria de Dota, *Standley* 42481 (US); CARTAGO: Cerro de La Carpintera, *Standley* 34209 (US). PANAMA: CHIRIQUÍ: Chiriquí Volcano, *Scholander* s.n. (US).

BERMUDA: Payutes, s.c. (K). CUBA: PINAR DEL RÍO: Between Viñales and Pinar del Río, *Imshaug* 25320 (MSC, US); Sierra de las Yequas, *León* 5264 (FH); ISLE OF PINES: Rocky Point, *Britton* 15415 (FH, NY); ORIENTE: Summit of Pico Turquino, Sierra Maestra, *Imshaug* 25128 (MSC, US); slopes of El Gato, Loma del Gato, *Imshaug* 24773 (MSC). HAITI: East end of Montagne Noire, near Kenscoff, *Imshaug* 22533 (MSC, US); ridge leading to Pic Macaya, Morne Macaya, *Wetmore* 3238 (MSC); summit of Tête Etang, *Imshaug* 22608 (MSC). DOMINICAN REPUBLIC: Casabito, La Vega, *Wetmore* 3430 (MSC); between Pico del Yaque and Chinguela, *Wetmore* 3723 (MSC, US); Constanza, near Valle Nuevo, *Allard* 17692, 17696 (US); Sabana de la Rosa near Km. 28, *Allard* 15971 (US). JAMAICA: John Crow Peak, *Imshaug* 15365 (MSC); slope of Catherine's Peak, Blue Mountains, *Imshaug* 13399 (MSC, US); without locality, *Hart* 122 p.p. (NY); Albion, St. Ann., *Imshaug* 15914 (MSC); near Guys Hill, St. Ann., *Imshaug* 13647 (MSC). PUERTO RICO: Lares to

San Sebastian, *Britton* 2789 (FH). DOMINICA: Roseau, *Evans* 57 (NY, YU).
VENEZUELA: Cerro Yapacana, Río Orinoco, *Maguire* 30818 (MO); Avila, *Vogl* s.n. (M); Caracas, *Linden* 380 (K); BOLÍVAR: Ptari Tepui, *Steyermark* 59952 (MO); Salto de Auraima, Río Paragua, *Killip* 37371a (US). COLOMBIA: NORTE DE SANTANDER: Región del Sarara, *Cuatrecasas* 12525 (US); MEDELLÍN: Vicinity of Medellín, *Charetier* 192 (US); CUNDINAMARCA: Bogotá, *Lesdain* s.n. (MO), *Apollinaire* s.n. (MO, US). ECUADOR: Recreo, *Eggers* (F); without locality, *André* 826 (K). PERU: SAN MARTÍN: Tingo Maria, *Allard* 21644, 22424 (US), *Morrow* 9605 (US). BOLIVIA: Mapiri, *Bang* 1750 (US); Trinidad, Beni, *Werdermann* 2305b (S). BRAZIL: MINAS GERAIS: Sitio, *Vainio Lich. Bras. Exs.* 397 (BM, M), 538b (K); GOIAS: east of Rio Verde on Goiania Road, *Cutler* 8029 (F); MATO GROSSO: Santa Anna da Chapada, *Robert* 650 (BM); Buriti, Serra da Chapada, *Malme* s.n. (S); Coxipó, near Cuyabá, *Malme* 2198 (S).
FRANCE: Coatloch, Finistère, *des Abbayes, Lich. Armor. Exs. Sel.* 31 (LD); Forêt du Cranou, just northwest of St. Conval, Bretagne, *Santesson* 10278a (UPS, US). PORTUGAL: Serra de Cintra, Monserrate, Estremadura, *Tavares, Lich. Lus. Sel. Exs.* 45 (H, US, WIS).
LIBERIA: Belleyella, Boporo Distr., *Baldwin* 12311 (US). GUINEA: Nimba Mountains, cercle of Zérékoré, *Santesson* 10562a (UPS). CONGO: Isalowe Reserve, *Louis* 8648 (BR); Kabalo, Katanga, *Höeg,* s.n. (TRH). ANGOLA: MOXICO: Lucusse, *Degelius,* Feb. 13, 1960 (DEGEL); between Luso and Cachipoque, *Degelius,* Feb. 16, 1960 (DEGEL); HUILA: Caconda, *Degelius,* Feb. 8, 1960 (DEGEL); CUANZA-SUL: Faz. Ceres, Mt. Chitandalua, *Degelius,* Feb. 21, 1960 (DEGEL); BIÉ: Munhango, *Degelius,* Feb. 10, 1960 (DEGEL); Caio, Hambe Region, *Gossweiler* 8013 (BM). MOÇAMBIQUE: Tinga-Tinga, Inhambane, *Schelpe* 4469, 4469a (LD); near Maxixe, Inhambane Mongue, *Schelpe* 4463a, b (LD); Inhaca Island, *Leighton* 3324, 3325 (LD). SOUTHERN RHODESIA: South of Felixburg Station, *Höeg* s.n. (TRH); M'Ulnaluska River, *Richard* s.n. (K). UNION OF SOUTH AFRICA: TRANSVAAL: Near the Punch Bowl, Louis Trichardt, Zoutpansberg, *Almborn* 6244 (LD).
SINGAPORE: *Johnson* A–109 (US). PHILIPPINES: Camp Keithley, Mindanao, *Clemens* 1300 (US). BORNEO: Sarawak, *Brooke* 10204 (BM). AUSTRALIA: NEW SOUTH WALES: Tilba-Tilba, *Render* s.n. (BM); QUEENSLAND: Cairns, *Fitzalan* s.n. (BM).

9. Parmelia disparilis Nyl. Syn. Lich. 1:381. 1860.

Parmelia odontata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:185. 1899. Type collection: Bourbon, *Rodriguez* in 1889 (P, holotype).

P. tephrina Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:183. 1899. Type collection: Nilgherries Mountains, Coonoor, India, *Gray* in 1893 (P, holotype).

P. appendiculata Fée f. *disparilis* (Nyl.) des Abb. Mem. Inst. Sci. Madagascar, ser. B, 7:11. 1956.

Type collection: Nossi-Bé, Madagascar, *Pervillé* 1847–52 (P, lectotype).

Thallus loosely adnate to bark, up to 15 cm. in diameter or more, mineral gray; lobes rotund, 10–14 mm. wide, often suberect, margins conspicuously laciniate, laciniae to 10 mm. long, becoming caniculate, cilia absent or very sparsely developed in axils, 0.5 mm. long; upper surface smooth, shiny, more or less distinctly white-maculate, reticulately cracked with age; lower side black and sparsely rhizinate at the center, brown to ivory or mottled and naked in a broad zone along

the margins. Apothecia numerous, to 15 mm. in diameter, pedicellate, amphithecium rugose, white-maculate, exciple variable, from entire to dentate or even laciniate, disc imperforate; hymenium 90–100 μ high; spores 8–10×16–21 μ, episporium 1.5–2.0 μ thick; pycnidia common on laciniae, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia disparilis is very near *P. zollingeri* Hepp except for the distinct maculae and laciniae. The spores of *P. disparilis* tend to be somewhat smaller, although perhaps not significantly so. It is a rare species occurring in Asia, Africa, and Mexico. Its relation to *P. appendiculata* is discussed under that species.

Additional specimens examined:

MEXICO: Chiapas: El Sumidero, near Tuxtla Gutiérrez, *Hale* 20078 (DUKE, MSC, REN, S, TNS, US); road to El Suspiro, north of Berriozábal, *Hale* 20081, 20115 (US).

CONGO: Isalowe Flower Reserve, Yangambi, *Louis* 6596 (BR, US).

10. Parmelia dominicana Vain. Journ. Bot. Brit. & For. 34:32. 1896. Plate 3

Parmelia perlata var. *flavogranulosa* Vain. Ann. Acad. Sci. Fenn. 6, no. 7:13. 1915. Type collection: Mt. Stewart, St. Croix, *Raunkiaer* 433 (TUR, Vain. herb. no. 2362, holotype; C, isotype).

P. capitulifera Zahlbr. *in* Magn. Ark. Bot. 30B, no. 3:9. 1941. Type collection: Punaluu, Oahu, *Rock* 176 (W, lectotype; BPI, isotype).

Type collection: Crater, Souffrière, Dominica, *Elliott* 114 (TUR, holotype).

Thallus adnate to loosely adnate, saxicolous or corticolous, up to 15 cm. in diameter, mineral gray with a pale yellowish tinge to distinctly yellowish green; lobes rotund, 8–12 mm. wide, margins sorediate laterally, soralia irregular to subcapitate, confluent, in part sublaminal, tinged distinctly yellowish, cilia lacking; upper surface opaque, reticulately cracked with age; lower side black and sparsely rhizinate, brown and naked in a rather broad zone along the margins. Apothecia very rare, 3–5 mm. in diameter, adnate, amphithecium sorediate, disc imperforate; hymenium 65–70 μ high; spores 5–7× 16–18 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, fading, P+ orange red, atranorine, usnic acid, and protocetraric acid present.

Parmelia dominicana is distinguished by the yellowish farinose soralia caused by the large concentration of usnic acid in the soredia. Most yellow Parmelias produce usnic acid only in the cortex and the soredia remain white. The concentration of usnic acid in the cortex of *P. dominicana* varies considerably, specimens from tropical America being more or less mineral gray with traces of usnic acid and specimens from Hawaii and Africa being distinctly yellowish green.

It is a typical weedy species in disturbed areas of tropical America, occurring more rarely in Hawaii and Africa (fig. 13).

Additional specimens examined:

U.S.: North Carolina: Smith Island, Brunswick Co., *Culberson* 7996 (DUKE, US); Florida: Gold Head Branch St. Park, Clay Co., *Hale* 17695 (US); Sanford, Seminole Co., *Rapp*, Apr. 4, 1924 (FLAS, US); Snake Key, Dade Co., *Baker*, s.n. (FLAS). MEXICO: Veracruz: 24 km. northwest of San Andrés Tuxtla, *Hale* 19775 (US); Oaxaca: Cerro San Felipe, *Hale* 20747 (US); Km. 686 on highway 190, northwest of Tehuantepec, *Hale* 20645 (TNS, US); Chiapas: 2 km. east of Oaxaca-Chiapas State line, on highway 190, *Hale* 19888 (S, US); Km. 956 on highway 190, west of Ocozocoautla, *Hale* 20596 (US). NICARAGUA: Jinotega: Vicinity of Jinotega, *Standley* 9573 (F).

CUBA: Pinar del Rio: Alturas de Pizarras, *Imshaug* 25220, 25231 (MSC); above Matahambre, *Imshaug* 25314 (MSC); Oriente: Slope of El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24755 (MSC). HAITI: Northwest of Jacmel, *Thomas* 75 (NY). DOMINICAN REPUBLIC: Sabana de la Rosa, near Km. 28, Duarte Highway, *Allard* 15958 (US). JAMAICA: Bloxburgh Ridge, St. Andrew, *Imshaug* 15100 (MSC, US). PUERTO RICO: San Juan, *Britton* 292 (FH, NY); hills between Cabo Rojo and San German, *Britton* 4318 (NY). LESSER ANTILLES: Virgin Islands: Virgin Gorda, *Fishlock* 346 (FH, NY); St. Croix: No locality, *Raunkiaer* 433 (C); Dominica: Roseau, *Evans* 59 (FH), *Evans* 62 (US, Y), Crater, Souffriere, *Elliott s.n.* (TUR); no locality, *Campbell*, November 1958 (K); St. Barthelemy: Vité, *Le Gallo* 426a (MO).

COLOMBIA: Isla de Providencia, *Proctor*, Apr. 29, 1948 (MO, PH).

ANGOLA: Bié: Between Coemba and Munhango, *Degelius*, Feb. 10, 1960 (DEGEL); Huila: Sá da Bandeira, 10 km. north of Sá da Bandeira, *Degelius*, Feb. 3, 1960 (DEGEL); Moxico: Lucusse, River Lungué Bungo, *Degelius*, Feb. 13, 1960 (DEGEL, US); between Luso and Cachipoque, *Degelius*, Feb. 16, 1960 (DEGEL). CONGO: Southwest of Albertville, *Höeg*, Mar. 5, 1930 (TRH). SOUTHERN RHODESIA: South of Felixburg, *Höeg*, Feb. 4, 1930 (TRH).

HAWAII: Kauai: Kilauea, *Faurie* 79 (BM); Manamaulu, *Faurie* 81 (BM, LD); Oahu: Pumaluu Mtns., *Rock* 176 (BPI, FH, W).

11. Parmelia eborina Hale, sp. nov. Plate 3

Thallus late expansus, rigidulus, laxe umbrosa ad saxa adnatus, cinereo-albicans vel eborinus, 10–15 cm. latus, lobis rotundatis, pro parte imbricatis, 8–15 mm. latis, ciliis, sorediis, isidiis destitutis, superne opacus, continuus, strato corticeo superiore 18–20 μ crasso, strato gonidiali 20–22 μ crasso, medulla alba, 80–100 μ crassa, strato corticeo inferiore 20–22 μ crasso, subtus ater, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia rara, 3–5 mm. diametro, nonnihil pedicellata, disco imperforato; hymenium 70–80 μ altum; sporae 5–7×11–14 μ, episporio 1 μ; pycnidia numerosa; conidia 1×5–7 μ. Thallus K+ flavescens; medulla K—, C—, KC+ fugiter rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the Chicago National History Museum, collected in the vicinity of El Zamorano, Morazán, Honduras, Nov. 26, 1946–Jan. 9, 1947, by P. C. Standley (no. 236).

Parmelia eborina is probably rather common on shaded rocks in Central America and more rarely in the West Indies. The distinguishing features are the lack of soredia and isidia, the presence of protocetraric acid, and the ashy white, often monophyllous thallus which may break apart easily in the herbarium. One other species with protocetraric acid and without isidia, *P. zollingeri* Hepp, has larger spores, a rigid thallus, and corticolous habit.

Additional specimens examined:

HONDURAS: Comayagua: Comayagua, *Standley* 5762 (F); Morazán: Las Mesas, elev. 900 m., *Standley & Williams* 46, 49 (F); vicinity of El Zamorano, *Standley* 137 (F, US), 220 (F), 308 (F), 1692 (F, MO), 2267 (F), 11661 (F, US); El Paraiso: Las Casitas, *Standley et al.* 596 (F).

DOMINICAN REPUBLIC: Monción, Monte Cristo, *Valeur* 203 (US).

COLOMBIA: Isla de Providencia, *Proctor*, Apr. 29, 1948 (MO).

12. Parmelia ebulliens Hale, sp. nov.

Thallus laxe adnatus, 8–12 cm. diametro, rigidus, cinereo-albicans vel eborinus, lobis 6–10 mm. latis, contiguis et partim imbricatis, marginibus integris vel crenatis, plus minusve convolutis irregulariter laciniato-lobatis, isidiis, sorediis, ciliis destitutis, superne planus, opacus, minute rimosus in aetate, strato corticeo superiore 20–25 μ crasso, strato gonidiali 22–26 μ crasso, medulla inconspicue flavida, 100–130 μ crassa, strato corticeo inferiore 14–16 μ, inferne niger, sparse rhizinosus, ambitu castaneus, anguste nudus. Apothecia numerosa, breve pedicellata, 5–8 mm. diametro, amphithecio rugoso, albomaculato, excipulo rimoso, radiato-fissurino, disco imperforato; hymenium 100 μ altum; sporae 10–15$\times$25–28 μ, episporio 2 μ crasso; pycnidia numerosa, conidiis 1$\times$4–5 μ. Thallus K+ flavescens; medulla K−, C−, KC−, P−, atranorinum, acidum incoloratum ignotum et pigmentum flavidum ignotum continens.

Type in the University of Michigan, collected at Mt. Ovando, Chiapas, Mexico, April 1936, by E. Matuda.

Parmelia ebulliens externally resembles a small fertile specimen of *P. zollingeri* Hepp, or if sterile, *P. eborina* Hale. The pale-yellow medulla and peculiar chemistry set it apart from both of these species. The residue from acetone is abundant and resembles the residue of evernic acid. However, no crystals are formed in either G.A.W. or G.E., and addition of these reagents or KOH causes bubbling and dissolution of the residue. Lamellar plates are formed in G.A.Q. but these have not been identified further. *Parmelia ebulliens* is apparently corticolous in Mexico, but the Jamaican specimens are saxicolous.

Additional specimens examined:

MEXICO: Chiapas: Mt. Ovando, *Matuda*, December 1937 (MICH, US).

JAMAICA: Trail from Content Gap to Flora River, elev. 2850 ft., St. Andrew, *Imshaug* 14365 (MSC).

13. Parmelia endosulphurea (Hillm.) Hale, comb. nov.

Parmelia tinctorum var. *endosulphurea* Hillm. Repert. Sp. Nov. Fedde 48:8. 1940.

P. praetervisa Müll. Arg. var *flavicans* Müll. Arg. Flora 71:494. 1888. Type collection: Cayey, Puerto Rico, *Sintenis* 21 (G, holotype).

P. tinctorum var. *chrysophora* Zahlbr. ex Hillm. Repert. Sp. Nov. Fedde 48:10. 1940. Type collection: Near Batavia, Java, *Schiffner* 3196 (W, lectotype; WU, isotype).

Type collection: Mexico, *Orcutt* 4728 (MO, holotype).

Thallus loosely adnate, 10–15 cm. broad, light mineral gray; lobes rotund, 10–15 mm. wide, margins entire, cilia lacking; upper surface plane, opaque, densely isidiate, isidia 0.06–0.08 mm. in diameter, to 3 mm. high, simple to sparingly branched; medulla pale orange yellow, especially near the upper cortex; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia rare, short-stalked, 5–10 mm. in diameter, disc imperforate; hymenium 65–80 μ high; spores 6–9 $\times$ 19–23 μ, episporium 1.5–2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+, C+, KC+, more intensely yellow, P—, atranorine, an unidentified pigment, and unknown substances present.

I published a note identifying a large number of tropical specimens previously identified as *P. sulphurata* Nees & Flot. with *P. lindmanii* Lynge (Hale, 1959a). More critical study has shown that *P. lindmanii* is actually a *Hypotrachyna* species, although quite broad lobed and chemically identical with the *Amphigymnia* species. *Parmelia lindmanii* has axial cilia and small spores (5–8 $\times$ 10–13 μ); it is a rather rare species known only from southern Brazil, Uruguay, Paraguay, and Argentina. All of the remaining isidiate specimens with a pale sulphurous medulla are true Amphigymnias, lacking any trace of axial cilia, having broader lobes with a distinct bare zone below, and, when fertile, intermediate-sized spores (6–10 $\times$ 18–23 μ). The correct name for this species is *P. endosulphurea*. It is extremely common in the Caribbean region but much rarer elsewhere (fig. 14). The chemistry is not clear except that the pigment is the same one found in *P. appendiculata* Fée, *P. araucariarum* Zahlbr., and others.

Additional specimens examined:

U.S.: Alabama: Pocosin, 4 mi. southeast of Troy, Pike Co., *McCullough* 453 (US); Florida: Gainesville, Alachua Co., *Nelson* s.n. (FLAS); Suwanee River State Park, Suwanee Co., *Hale* 17636 (US); Orange Park, Clay Co., *Hale* 17743 (US); Everglades National Park, Dade Co., *Degelius*, Nov. 22, 1939 (DEGEL), *Imshaug* 23955 (MSC); Texas: 3 mi. east of Edna, Victoria Co., *Darrow* (TAES). MEXICO: Veracruz: 24 km. northwest of San Andrés Tuxtla, *Hale* 19763 (US); 15 km. south of Catemaco, *Hale* 19797 (US); Chiapas: 50 km. west of Tuxtla Gutiérrez, *Hale* 19941 (DUKE, MSC, REN, S, TNS, US). COSTA RICA: Guanacaste: Upper slopes of Cerro San José de Libano, *Dodge* 7962 (MICH);

LIMÓN: Portete, *Quiros* 1478 (MO); vicinity of Guápiles, *Standley* 37398 (US). PANAMA: Juan Mina, Chagres River, Canal Zone, *Bartlett* 16822 (MICH); Barro Colorado Island, *Aviles* 945 (F).

BAHAMAS: New Providence, *Britton* 6583 p.p. (FH, NY). CUBA: PINAR DEL RÍO: Sumidero, *Shafer* 13926 (FH); LAS VILLAS: Trinidad Mountains, *Imshaug* 24598 (MSC). HAITI: Below Citadelle, south of Milot, *Wetmore* 2826 (MSC, US), 2859 (MSC); near Port Margot, *Nash* 99 (FH); Between Petionville and Ft. Jacques, *Thomas* 36a (NY). DOMINICAN REPUBLIC: Los Amaceyes, Cordillera Setentrional, *Wetmore* 3400, 3406 (MSC); Cerrazo, on ridge from La Cumbre to Santiago, *Wetmore* 3844 (MSC, US), 3871 (MSC); Guama, Santiago, *Wetmore* 3906 (MSC, US); west of Ciudad Trujillo, *Allard* 16794a, 16778 (US); Repressa Dam, near Maná, *Allard* 17285, 17287 (US); Hato Major, along Río Magua, *Thomas* 32 (NY). JAMAICA: 1 mi. northwest of Stewart's Town, *Pierce* 510 (PH); Farm Hill, St. Thomas, *Orcutt* 3551a (US); Birch's Hill, Hanover, *Imshaug* 15724 (MSC); Mt. Diablo, St. Catherine, *Imshaug* 13782, 14241 (MSC); Mandeville, *Cushman* 8 (FH); Santa Cruz Mountains, *Britton* 483 (FH); below August Town, St. Andrew, *Imshaug* 13637 (MSC); Hopewell, St. Ann, *Imshaug* 15805 (MSC, US). PUERTO RICO: Sardinera, Mona Island, *Britton* 1801 (FH, NY); near Maricao, *Sintenis* 2 (G); near Aibonito, *Sintenis* 55 p.p. (G); Adjuntas, *Sintenis* 79 (G); Monte Montoso, *Britton* 4180 (FH, NY); Mayaguez, *Fink* 1326 (FH, G); Naranjito, *Fink* 279 (FH). U.S. VIRGIN ISLANDS: ST. THOMAS: Bonne Resolution, *Britton* 444 (FH, NY); ST. JOHN: Makumli, *Raunkiaer* 442 (C); Sussanaberg, *Boergesen* s.n. (C). BRITISH VIRGIN ISLANDS: TORTOLA: *Eggers* 3192 (C), *Fishlock* 502 (FH, NY); VIRGIN GORDA: *Fishlock* 345 (FH, NY). GUADELOUPE: Trois Rivières, *Le Gallo* 421, 558 (MO). MARTINIQUE: Without locality, *Husnot* 442 (G); Fonds-St.-Denis, *Degelius*, May 26, 1958 (DEGEL); La Pagerie, *Degelius*, May 17, 1958 (DEGEL). ST. LUCIA: *Murray* (G). BARBADOS: Welchman's Hall Gully, *Evans* s.n. (YU). TRINIDAD: San Fernando Palmiste, *Broadway* 8987 (K).

VENEZUELA: MÉRIDA: Río Chama Valley, Mérida, *Dennis* 1673 (K). COLOMBIA: BOLÍVAR: Torrecilla, near Turbaco, *Killip & Smith* 14675 (US). CHILE: Without locality, *Barclay*, 1836 (BM). BRAZIL: RIO DE JANEIRO: Rio de Janeiro, *Glaziou* 1842 (M), *Milne*, s.n. (K), *Vainio, Lich. Bras. Exs.* 480 (BM); BAHIA: São Beulo, *Leutzelburg* 296a (M); RIO GRANDE DO SUL: Encrusilhada do Sul, *Cuezzo* 13371 (F); SÃO PAULO: Near Conceicão de Itanhaen, *Schiffner* (BM).

IVORY COAST: Forêt d'Akadiedon, *des Abbayes* s.n. (S). MADAGASCAR: Fort Carnot, *Decary* s.n. (LD).

JAVA: Buitenzorg Garden, Batavia, *Schiffner* 3196 (FH). FIJI: Suva, *Edmondson* s.n. (BISH, US).

Localities already published by Hale (1959a) for Florida, Louisiana, Grenada, El Salvador, British Honduras, Nicaragua, and Uruguay (excluding the type of *P. lindmanii* Lynge) are not repeated in this list.

14. Parmelia fasciculata Vain. Hedwigia 38:122. 1899.

Parmelia fatiscens Lynge, Ark. Bot. 15, no. 1:1. 1917. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* (S, holotype).

Type collection: Bogotá, Colombia, *Weir* 66 (K, holotype; TUR, isotype).

Thallus loosely adnate on bark, 5–15 cm. in diameter, mineral gray, often with a yellowish tinge; lobes rotund, 6–12 mm. wide, margins of lobe tips entire, lateral margins laciniate and dissected, laciniae

developing into large coralloid clusters to 4 mm. high, sometimes becoming pustular or sorediate-pustulate, cilia very rarely developed; upper surface plane, dull, reticulately cracked with age; lower side black and sparsely rhizinate in the center, brown and naked in a broad zone along the margins. Apothecia rare, 3–6 mm. in diameter, substipitate, amphithecium irregularly pustulate, disc imperforate; hymenium 50–65 μ high; spores 8–10×18–20 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish orange, fading, P+ brick red, atranorine, protocetraric acid and traces of usnic acid present.

The most unusual feature of *P. fasciculata* is the large coralloid outgrowths which superficially resemble tiny thalli of *Stereocaulon*. They originate from marginal laciniae or directly from the upper cortex. The tips of the branches are warty and sometimes become pustulate but never develop true soredia. The species is quite rare. It seems to be related to *P. dilatata* Vain., which may develop similar, although far less conspicuous, coralloid outgrowths along with coarse soredia. Both species are faintly maculate. *Parmelia ramuscula* Hale and *P. flavotincta* Hale have similar coralloid structures but differ in chemistry.

Additional specimens examined:

JAMAICA: East Peak, Blue Mountains, *Imshaug* 14833 (MSC).
LIBERIA: Firestone Plantations, Harbel, *R. Hale*, Oct. 1958 (US).

15. Parmelia latissima Fée, Ess. Crypt., suppl. 119, *pl. 38, fig. 4.* 1837.

Type collection: Jamaica, *s.c.* (G, lectotype).

Thallus large, expanded, loosely attached to bark, 10–25 cm. in diameter; lobes rotund, 8–20 mm. wide, margins entire; upper surface plane, dull, continuous or becoming reticulately cracked with age, soredia and isidia lacking; lower side black and rhizinate, brown and naked in a broad zone at the margin. Apothecia common, adnate to substipitate, disc imperforate; hymenium 100–120 μ high; spores 14–16×28–32 μ, episporium 3–4 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Fée described *P. latissima* from two collections in tropical America. Fortunately Müller-Argau kept fragments of both of these specimens. The lectotype follows the accepted concept of *P. latissima*, a plant with the medulla reacting K+ red; the other specimen is *P. zollingeri* Hepp (medulla K−, protocetraric acid present). *Parmelia latissima* represents the simplest kind of *Amphigymnia*, having more or less adnate imperforate apothecia and lacking isidia, soredia, cilia, and maculae. *Parmelia zollingeri* is very close, as is *P. crassescens* Stirt., but both of these species may be separated by different chemistry and

smaller spores. The sorediate counterpart is *P. cristifera* Tayl. *Parmelia latissima* is virtually restricted to tropical America except for one locality in India (cf. fig. 3). The name has been used incorrectly in the literature many times and has often been cited as the parent species for numerous varietal taxa.

Additional specimens examined:

MEXICO: Veracruz: 15 km. south of Catemaco, *Hale* 19843a (US); Chiapas: El Sumidero, near Tuxtla Gutiérrez, *Hale* 20187 (MSC, US); 50 km. west of Tuxtla Gutiérrez, *Hale* 21050 (DUKE, US); El Suspiro, 9 km. north of Berriozábal, *Hale* 21232 (US); Campeche: Tuxpeña, *Lundell* 1303 (F). HONDURAS: Atlántida: Lancetilla, near Tela, *Standley* 54210, 54606, 55415 (F). NICARAGUA: Vicinity of Casa Colorado, near El Crucero, *Standley* 8603 (F). COSTA RICA: Guanacaste: Vicinity of Tilarán, *Standley* 44428 (US); Alajuela: San Ramón, *Brenes* 14462a (MO); Cartago: Potrero at Santiago, *Dodge* 4557 (MICH); Turrialba, *Maxon* 206 (MO); El Muñeco, south of Navarro, *Standley* 33676 (US).

BAHAMAS: New Providence, *Britton* 3239 (FH, NY); Marsh Harbor, Abaco, *Brace* 1658 (FH, NY). CUBA: Without locality, *Wright, Lich. Cubae* 67 (BM, FH, K, M, UPS, US); Pinar del Río: Source of Río Taco-Taco, Sierra de los Organos, *Morton* 4280 (MO, US); San Diego de los Baños, *Earle & Murrill* 258 (FH), *Palmer & Riley* 607 (US); Habana: Cayo Largo, *Proctor* s.n. (PH); Oriente: Gran Piedra, *Shafer* 9118 (FH); La Prenda, *Hioram* 2590 (NY), 6102 (BPI); Loma del Gato, *León* 9849, 9886, 9998 (BPI, NY), *Imshaug* 24784, 24805, 24949 (MSC, US), *Hioram* 6694 (US). GRAND CAYMAN: East End Island, *Lewis* 11 (PH). HAITI: Northwest of Jacmel, *Thomas* 77 (FH, MO, US); Port Margot to Corrut, *Nash* 224 (FH); summit of ridge north of Forêt des Pins, Dept. l'Ouest, *Wetmore* 3155 (MSC), *Imshaug* 22697 (MSC, US). DOMINICAN REPUBLIC: Vicinity of Constanza, La Vega, *Allard* 17694b (US). JAMAICA: Moseley Hall Cave, *Imshaug* 13669 (MSC, US), 13676 (MSC); Coopers Hill, Red Hills, St. Andrew, *Imshaug* 14145 (MSC, US), 13732, 13712, 13715, 13716 (MSC); Birches Hill, Hanover, *Imshaug* 15675 (MSC); Mandeville, *Cushman* 1 (FH, NY); Claremont, *Orcutt* 3979 (US); Castleton, *Underwood* 1938 (FH), *Plitt* s.n. (BPI); Hollymount, Mt. Diablo, St. Catherine, *Imshaug* 14218 (MSC, US); Silver Hill Gap, Blue Mountains, *Imshaug* 14083 (MSC); Beaufort, *Wullschlaegel* 1256 (M); Coldspring Gap, *Purdie* s.n. (K); near Lydford P.O., *Proctor* 8654 (PH); without locality, *Eggers* 3721, *Hansen* s.n. (C). PUERTO RICO: Mayaguez, *Fink* 1022 (NY). GUADELOUPE: Pointe à Pitre, *Questal* 9 (MO). CURAÇAO: La Vela, *Curran & Haman* 513 (US).

VENEZUELA: Bolívar: Río Paragua, Salto de Auraima, *Killip* 37371 (MO, US). COLOMBIA: Choco: Port Utria, *Taylor* 879 (H, K). PERU: Ayacucho: Estrella, *Killip & Smith* 23068 (US); Mito, *Bryan* 222 (F); Lamas, *Spruce* 112/2 (K). BRAZIL: Mato Grosso: Santa Anna da Chapada, *Robert* 649 (BM, K), 650 (BM, K, US), 651 (K).

INDIA: Calcutta, *Wallich* (BM). MARQUESAS: Nukuhiva, near Hakaui, *Brown* 472 (BISH, US).

16. Parmelia mesogenes Nyl. Flora 68:609. 1885.

Type collection: Orizaba Peak, Mexico, *Galeotti* 6958 (P, holotype).

Thallus saxicolous or corticolous, expanded, rather adnate, to 15 cm. broad, mineral gray; lobes rotund, 8–12 mm. wide, margins entire; upper surface plane, opaque, isidia, soredia, and cilia lacking; medulla

white or turning orange red near the lower cortex; lower side black and moderately rhizinate, brown, shiny, and naked in a broad zone at the margins. Apothecia common, stalked to substipitate, 6–8 mm. in diameter, disc imperforate; hymenium 115–130 μ high; spores 12–14×21–30 μ, episporium 2.0–2.5 μ; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, pigmented medulla K+ purple, atranorine, an unknown anthraquinone, and unknown colorless substances crystallizing in G.E.

Parmelia mesogenes has few distinguishing features since it lacks soredia, isidia, and maculae and is negative with color tests. The unknown acid crystallizes in G.E. as very large needle clusters. The pigment, which is found even in the lobe tips, is identical with the one in *P. erasmia* Hale and *P. hypomiltoides* Vain. *Parmelia mesogenes* is both saxicolous and corticolous in wet cloud forests where banana plantations are found. It is endemic to Mexico but will probably eventually be found in other parts of Central America.

Additional specimens examined:

MEXICO: Veracruz: Mirador, *Liebmann* 7562b (C); Teocello Canyon, just south of Xico, *Hale* 21150 (S, TNS, US), 21156 (DUKE, REN, US), 21175 (US); northeast of Huatusco, *Hale* 19521 (US); 7 km. north of Fortín de las Flores, *Hale* 19694 (US); 46 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19407a (US); Chiapas: El Sumidero, Tuxtla Gutiérrez, *Hale* 20026 (US).

17. Parmelia mesotropa Müll Arg. Rev. Mycol. 10:55. 1888.

Parmelia saccatiloba Tayl. f. *membranacea* Lynge, Ark. Bot. 13, no. 13:67. 1914. Type collection: Pilcomayo, Gran Chaco, Paraguay, *Malme*, 1893 (S, holotype).

P. subregressa Lynge, Ark. Bot. 13, no. 13:58. 1914. Type collection: Paraguari, Paraguay, *Malme* 1525B (S, holotype).

Type collection: Asunción, Paraguay, *Balansa s.n.*, 1878 (G, lectotype).

Thallus adnate to bark, 5–10 cm. in diameter, light mineral gray; lobes rotund, 5–8 mm. wide, margins entire to broadly crenate; upper surface plane, opaque, reticulately cracked with age, isidia, soredia, and cilia lacking; lower side black and sparsely rhizinate, brown and naked in a rather narrow zone along the margins. Apothecia numerous, 5–8 mm. in diameter, amphithecium maculate, disc imperforate; hymenium 60–90 μ high; spores 7–11×15–21 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and caperatic (mixed with protolichesteric acid?) present.

Parmelia mesotropa resembles *P. latissima* Fée and *P. zollingeri* Hepp in external appearance and the lack of soredia, isidia, and cilia, but it is too small to be confused with either of these species. It

differs furthermore in the P— reaction. The sorediate counterpart of *P. mesotropa* appears to be *P. praesorediosa* Nyl., a much more widely distributed species.

Additional specimens examined:

MEXICO: Oaxaca: 77 km. northwest of Tehuantepec, *Hale* 20631 (US). GUATEMALA: Jutiapa: Jutiapa, *Standley* 75250, 75949 (MO); El Barrial, east of Jutiapa, *Standley* 75816 (F, US); between Jutiapa and La Calera, *Standley* 76106 (F).

BOLIVIA: El Beni, Trinidad, *Werdermann* 2389 (S). BRAZIL: Mato Grosso: Santo Antonio, near Cuyabá, *Malme* 215CB (S); Santa Anna da Chapada, *Malme* 2392** (S). URUGUAY: Río Verde, Chaco, *Herter* 84954 (MO) PARAGUAY: Pilcomayo, Gran Chaco, *Malme,* Sept. 7, 1893 (S); Asunción, *Malme* 1678** (S).

18. Parmelia myelochroa Hale, sp. nov. Plate 3

Thallus laxe adnatus, usque ad 15 cm. latus, rigidus, viridi- vel albido-glaucescens, lobis primo rotundatis, demum late revolutis, paulo congestis, 8–12 mm. latis, margine parce dentato-laciniatulis vel integris, superne laevigatus, nitidulus, centrum versus rugosus, cortice continuo, sorediis isidiisque destitutis, strato corticeo superiore 11–15 μ crasso, strato gonidiali 11–15 μ crasso, medulla luteo-flavens, 100–125 μ crassa, strato corticeo inferiore 11–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia numerosa, pedicellata, 7–15 mm. lata, disco imperforato, amphithecio rugoso, albo-maculato; hymenium 75–90 μ altum; sporae 9–13×21–26 μ, episporio 1.5–2.0 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+ intensius flavescens, C+ flavescens, KC+ flavescens, P—, atranorinum, acidum barbaticum (?) et pigmenta ignota continens.

Type in the U.S. National Herbarium, collected in deciduous mist forest, elev. 1040 m., 50 km. west of Tuxtla Gutiérrez, Chiapas, Mexico, Mar. 18, 1960, by M. E. Hale (no. 21049; isotype in TNS).

Parmelia myelochroa is a tropical American species rarely seen among older herbarium collections. It was recognized by Zahlbruckner from Schiffner's Brazilian collections as *P. sulphurata* f. *nuda,* an herbarium name only. Externally it resembles *P. latissima* Fée, with which it is often found. However, *P. myelochroa* has a conspicuous yellow-orange medulla and intermediate spores. The chemical components are still not fully known. *P. araucariarum* Zahlbr. and *P. endosulphurea* (Hillm.) Hale are respectively the sorediate and isidiate counterparts of *P. myelochroa.*

Additional specimens examined:

MEXICO: Chiapas: 50 km. west of Tuxtla Gutiérrez, *Hale* 20214 (US), 19909 (S, US). HONDURAS: Comayagua: Near Siguatepeque, *Yuncker et al.* 6499 (F).

PERU: Selva Real, Tingo María, *Morrow* 9654 (US, WJC). BRAZIL: MINAS GERAIS: Road to São Miguel, *Mexia* 5239 (MO, S, US); São Paulo: Mt. Jaraguá, near Taipas, *Schiffner*, June 1901 (BM, M, WU).

19. Parmelia pancheri Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:202. 1899.

Type collection: New Caledonia, *Pancher* (P, holotype).

Thallus large, 10–20 cm. in diameter, loosely attached to bark, mineral gray; lobes rotund, to 10 mm. wide, more or less imbricate and crowded toward the center, margins smooth, sometimes narrowly black rimmed, cilia lacking, upper surface smooth to rugose with age, soredia and isidia lacking, opaque; lower side black and sparsely rhizinate, brown to tan and naked in a broad zone along the margins. Apothecia large, to 30 mm. in diameter, stalked, amphithecium rugose-maculate, disc perforate; hymenium 50–60 μ high; spores 5–9×12–18 μ, episporium 1.0–1.5 μ thick; pycnidia abundant.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

When I first examined the holotype of *P. pancheri*, I considered the lack of cilia to be an abnormal condition since all other species with alectoronic acid have cilia. After examining several other collections, I realized that the lack of cilia is normal for this species. Maculae are not noticeably developed. Except for the collection from Thailand, *P. pancheri* is known only from New Caledonia.

Additional specimens examined:

THAILAND: Doi Sutep, *Tsuyama* 7 (TNS,US). NEW CALEDONIA: No locality, *Pionniero*, 1907 (DUKE).

20. Parmelia peralbida Hale, sp. nov. PLATE 5

Thallus laxe adnatus vel adnatus, membranaceus vel rigidulus, cinereo-candidus vel albicans, 5–10 cm. diametro, lobis rotundatis, vulgo monophyllosis, usque ad 15 mm. latis, ciliis destitutis, modice isidiatis, isidiis tenuibus, simplicibus, 0.03–0.08×0.3–1.0 mm., superne planus, nitidus, aetate leviter rimosus, strato corticeo superiore 30–40 μ crasso, strato gonidiali 20 μ crasso, medulla alba, 140–150 μ crassa, strato corticeo inferiore 20 μ crasso, inferne nigricans, sparse rhizinosus, versus ambitum castaneus, nitidus, late glaber. Apothecia rara, adnata, ad 4 mm. diametro, disco imperforato, amphithecio isidiato; hymenium 35–40 μ altum; sporae 5–7×8–10 μ (maturae?), episporio 1 μ; pycnidia dispersa; conidia 1×6–7 μ. Thallus K+ flavescens; medulla K−, C−, KC+ fugiter rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the Farlow Herbarium (Tuck), collected in Jamaica, 1884, by J. Hart (no. 124; isotype in K).

This species is characterized by the large whitish thallus, the very thin unbranched isidia, and the presence of protocetraric acid. It is

usually collected sterile so that the range of variation in spore size is uncertain. The low hymenium and the unusually small spores are noteworthy, if they prove to be consistent. *Parmelia peralbida* is known only from the Caribbean area. Two other species resemble it in having isidia and protocetraric acid. *Parmelia saccatiloba* Tayl. has large saccate lobes, coarser and shorter isidia, and large spores (24–26 μ long). It is known from four localities in the South Pacific. If it occurs among the sterile specimens from the Caribbean area, it would be difficult to tell it from *P. peralbida*. *Parmelia koyaensis* Asahina, an Asian species in subgenus *Parmelia* with slightly branched rhizines, is smaller but otherwise very similar in external appearance.

Additional specimens examined:

MEXICO: CHIAPAS: Lagos de Monte Bello, *Hale* 20397 (US). HONDURAS: MORAZÁN: Vicinity of El Zamorano, *Standley* 239 (F, US); La Montañita, *Standley* 12373 (F). PANAMA: CHIRIQUÍ: Monte Lirio, *Seibert* 1011 (MO).

HAITI: Ridge between Forêt des Pins and Petit Source, *Wetmore* 3076 (MSC). JAMAICA: No locality, *Hart* 102 pr.p. (NY); Main Ridge Gap, Blue Mountains, *Imshaug* 14757 (MSC); east of East Peak, Blue Mountains, *Imshaug* 14889 (MSC); New Haven Gap, Blue Mountains, *Imshaug* 15153 (MSC).

21. Parmelia praesorediosa Nyl. Sert. Lich. Trop. Labuan Singapore 18. 1891.

PLATE 5

Parmelia capitata Lynge, Ark. Bot. 13, no. 13:59, *pl. 1, figs. 4, 5.* 1914. Type collection: Rio Vermelho, near Bahia, Bahia, Brazil, *Malme* (S, holotype).

P. sanctae-crucis Vain. Ann. Acad. Sci. Fenn. 6, no. 7:14. 1915. Type collection: Near Fair Plain, St. Croix, *Boergesen* (C, holotype; TUR, isotype).

P. neglecta Asahina, Journ. Jap. Bot. 17:71, *fig. 77.* 1941. Type collection: Raisha, Formosa, *Asahina* F. 51 (TNS, holotype).

P. luzonensis Räs. Ann. Bot. Soc. Zool. Bot. Vanamo 3:78. 1948. Type collection: Panai-Kabayan, Benguet, Luzon, Philippines, *McGregor* 8806 (H, holotype).

P. subcetrarioides des Abbayes, Bull. Inst. Fr. Afr. Noire 13:974. 1951. Type collection: Kankan, Guinea, Africa, *des Abbayes* (REN, lectotype; US, isotype).

Type collection: Singapore, *Almquist* (H, Nyl. herb. no. 35547, holotype; S, isotype).

Thallus adnate, 5–10 cm. in diameter, mineral gray to buff; lobes 5–8 mm. wide, rotund, margins suberect and sorediate, soralia often crescent-shaped and in part submarginal, cilia lacking; upper surface smooth, dull; lower side black and rhizinate in the center, brown or mottled ivory at the margins. Apothecia rare, 4–10 mm. in diameter, short-stalked, amphithecium rugose, sorediate, disc imperforate; hymenium 70–80 μ high; spores 7–10×15–21 μ, episporium 1.2–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C—, KC—, P—, atranorine and caperatic acid present.

Parmelia praesorediosa is a pantropical species (fig. 15). It is both corticolous and saxicolous and occurs at low elevations, often on cultivated trees, apparently as a weedy species in areas disturbed by man. Margins of sorediate lobes are often sinuous and the soralia crescent-shaped. Externally it might be mistaken for small specimens of *P. cristifera* Tayl. or *P. dilatata* Vain., but the medulla is K−, P−. The nonsorediate counterpart is *P. mesotropa* Müll. Arg., a rarer tropical American species.

Additional specimens examined:

U.S.: South Carolina: Bulls Island, Charleston Co., *Culberson* 10031 (DUKE); near Creston, Calhoun Co., *Culberson* 7734, 7742 (DUKE); 3 mi. west of Sumter, Sumter Co., *Culberson* 7773 (DUKE); Alabama: Dupree, Houston Co., *McLennan* 6001001 (US); Florida: 5 mi. east of Greenville, Madison Co., *Hale* 17607 (US); Nittaw, Osceola Co., *Hale* 17711 (US); 5 mi. south of Tallahassee, Leon Co., *Hale* 16725 (US); Seffner, Hillsboro Co., *Cowan* s.n. (US); Upsala, Seminole Co., *Rapp* 660 (FLAS); 4 mi. northeast of La Belle, Glades Co., *Hale* 16867 (US); Louisiana: Grand Isles, Jefferson Parish, *Drouet* 9520 (F); Baton Rouge, East Baton Rouge Parish, *McFarland* 6 (WIS); 22 mi. south of New Orleans, Plaquemines Parish, *Smith* 12394 (US); Texas: Houston, Harris Co., *Fisher* 5199a (FH). MEXICO: Veracruz: 9 km. east of Jalapa, *Hale* 19421 (TNS, US); Teocello Canyon, south of Xico, *Hale* 21142 (MSC, US); Oaxaca: Northwest of Tehuantepec at Km. 719 on highway 190, *Hale* 20620 (DUKE, US); Chiapas: El Zapotal, Tuxtla Gutiérrez, *Hale* 19993 (S, US); Yucatán: Tekax, *Gaumer* 1210 (F). HONDURAS: Atlántida: Near Tela, *Standley* 53862 (F).

BAHAMAS: New Providence, *Britton* 3311 (FH); Soldiers Road, *Brace* 9790, 9907 (NY). CUBA: Without locality, *herb Montagne* (FH, K); Isle of Pines: La Cunagua, *Britton* 14586 (FH, NY); Pinar del Río: Valle de Silencio, Alturas de Pizarras, *Imshaug* 25293 (MSC, US); Habana: Santiago de las Vegas, *Hermann* 785 (F), *Roig* 1 (MO); Cojimar, *Arsène* 10859 (US); Camaguey: Camino Antón, *MacBride & Dahlgren* 74 (F); Oriente: La Prenda, *Manuel* 5692 (BPI); El Gato, Loma del Gato, *Imshaug* 24743 (MSC); Puerto Boniato Ridge, Santiago de Cuba, *Imshaug* 24653 (MSC). GRAND CAYMAN: Near Georgetown, *Imshaug* 24381 (MSC); East End Island, *Lewis* 12 (PH). HAITI: Behind Hotel Randan, east edge of Les Cayes, *Imshaug* 23127b (MSC, US); Bayeux, between Cap Haitien and Le Borgne, *Bartlett* 17783 (WIS). DOMINICAN REPUBLIC: Hayto Mayor, *Thomas* 33 (MO, NY); Santiago, *Imshaug* 23801 (MSC, US); Ciudad Trujillo, Santo Domingo, *Allard* 16182a (US); Valdesia Valley, Prov. Trujillo, *Allard* 17351, 17353 (US); along Río Inoa at Inoa, Santiago, *Imshaug* 23885 (MSC). JAMAICA: New Castle, *Cushman* 167 (FH); Clarks Town, Trelawny, *Imshaug* 16048 (MSC); Birch's Hill, Hanover, *Imshaug* 15672 (MSC); Stewart Town, St. Ann, *Imshaug* 16012 (MSC, US); Hope River below August Town, *Imshaug* 13629 (MSC, US); Hillshire Hummock, St. Catherine, *Imshaug* 13687 (MSC). PUERTO RICO: Aibonitó, *Fink* 1931 (FH); Manati, *Fink* 2120 (FH); Laguna Tortuguero, *Britton* 3869 (FH, NY); Río Piedras, *Johnston* 947a (FH, NY); San Juan, *Hioram* s.n. (FH, NY); Campo Alegre, *Stevenson* 2477 (US); near Cayey, *Sintenis* 38 (G). VIRGIN ISLANDS: St. Thomas: Mandal, *Britton* 1311 (FH, NY); Bonne Resolution, *Britton* 446 (FH, NY). GUADELOUPE: Basse Terre, *Le Gallo* 525 (MO); Rivières, *Le Gallo* 2602 (MSC). ST. BARTHELEMY: Vité, *Le Gallo* 409 (MO); Saline, *Le Gallo* 560 (MO). DOMINICA: Roseau, *Evans* 51, 60 (US, YU). MARTINIQUE:

Madiana Beach, *Degelius*, May 13, 1958 (DEGEL). TRINIDAD: Centeno, *Earle* s.n. (US); without locality, *Lassen* (C).

VENEZUELA: LARA: Near Barquisimeta, *Saer* 49 (US). FRENCH GUIANA: Cayenne, *Babington* s.n. (UPS). PERU: SAN MARTÍN: Tingo María, *Allard* 21453 (US). BRAZIL: Rio de Janeiro, *Milne* (K), *Widgren* (S, UPS); MINAS GERAIS: Rio Branco, Mareco, *Mexia* 5452a (US); RIO GRANDE DO SUL: Pareci Novo, *Lima* 82 (MO). PARAGUAY: Pilcomayo, Gran Chaco, *Malme*, Sept. 6, 1893 (S). ARGENTINA: TUCUMÁN: Pueblo Viejo, *Killip* 39515 (US).

GUINEA: 3–4 km. east of Divo, cercle of Grand Lahou, *Santesson* 10382a (UPS); 50 km. west of Guiglo, cercle of Man, *Santesson* 10487 (UPS). REPUBLIC OF CONGO: Brazzaville, *Degelius*, Mar. 12, 1960 (DEGEL, US). CONGO: Kabalo, Katanga, *Höeg*, Feb. 22, 1930 (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: Wyllie's Poort, Zoutpansberg, *Almborn* 6410 (LD); NATAL: Somkili, Nogoma, *Höeg* s.n. (TRH).

INDIA: 4–5 mi. from Tanakpur, Uttar Pradesh, *Awasthi* 3370 (AWAS). SUMATRA: Tandjung Alai, *Groenhart* 8990 (BO); Sawahpari, *Groenhart* 9210 (BO); north bank of Lake Singdarak, *Groenhart* 9287 (BO). JAVA: Bandung, *Groenhart* 8856 (BO). NEW CALEDONIA: *Compton* s.n. (BM).

Additional localities cited by Hale (1959a) (as *P. sanctae-crucis* Vain.) from Georgia, Florida, Alabama, Louisiana, the West Indies, Honduras, Nicaragua, Guinea, and Japan are not repeated here.

22. Parmelia pseudotinctorum des Abbayes, Bull. Inst. Fr. Afr. Noire 13:973, 1951. PLATE 1

Parmelia nitens f. *isidiosa* Müll. Arg. Bot. Jahrb. Engler 20:255. 1894. Type collection: Ririre, Karapo, Seen region, Tanganyika, Africa, *Stuhlmann* 3301 (G, holotype; K, isotype?, as 3201).

P. soredica var. *neghelliensis* Cengia-Sambo, R. Accad. Ital. Miss. Biol. Paese Borana 380. 1939. Type collection: Borana, Ethiopia, *Cufodontis* 193a (FI, holotype).

P. neghelliensis (Cengia-Sambo) Dodge, Ann. Mo. Bot. 46:120. 1959.

P. pseudotinctorum f. *perrugosa* des Abbayes, Bull. Inst. Fr. Afr. Noire 13:974. 1951. Type collection: Dalaba, Fouta-Djalon, cercle de Mamon, Guinea. *des Abbayes* (REN, holotype).

P. stuhlmannii Dodge, Ann. Mo. Bot. Gard. 46:137. 1959. Based on *P. nitens* f. *isidiosa* Müll. Arg.

Type collection: Mt. Tonkoui, cercle de Man, Ivory Coast, *des Abbayes*, Aug. 14, 1948 (REN, lectotype; US, isotype).

Thallus saxicolous, loosely adnate, 8–15 cm. in diameter, light mineral gray; lobes rotund, 8–12 mm. wide, margins entire to crenate; upper surface dull, isidiate, isidia inflated and irregular, 0.2–0.3 mm. thick, coarsely branched with age, to 0.5 mm. high; lower side black and sparsely rhizinate, light brown, shiny, and naked in a broad zone along the margins. Apothecia rare, 2–4 mm. in diameter, amphithecium coarsely isidiate, disc perforate or imperforate; hymenium about 40 μ high; spores poorly developed, 5–8×8–12 μ, episporium 1 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ red, P−, atranorine and lecanoric acid present.

Parmelia pseudotinctorum is identical with *P. tinctorum* Nyl. in habit and chemistry. It differs chiefly in having large inflated isidia, whereas *P. tinctorum* has uniformly thin cylindrical or even granular isidia.

Additional specimens examined:

IVORY COAST: Mont Tonkoui, cercle of Man, *Santesson* 10633 (*Almb. Lich. Africani* 30) (LD, UPS, US, WIS); Mankono, cercle of Seguela, *Santesson* 10711 (UPS).

23. Parmelia ramuscula Hale, sp. nov. PLATE 1

Thallus laxe adnatus, 8–10 cm. diametro, albicans, lobis rotundatis, 10–15 mm. latis, margine integris, centrum versus laciniato-dissectis, laciniis isidiiformibus, coralloideo-ramosis, usque ad 1 cm. altis, isidiis fatiscentibus, demum sorediatis, margine ciliatis, ciliis sparsis, 1 mm. longis, superne opacus, reticulatim rimosus in aetate, strato corticeo superiore 24–28 μ crasso, strato gonidiali 22–26 μ crasso, medulla alba, 110–140 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu fuscus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K+ rubra, C−, KC−, P+ aurantiaco-flava, atranorinum et acidum salacinicum continens.

Type in the British Museum, collected at Lawas, Sarawak, May 31, 1955, by W. M. A. Brooke (no. 10031; isotypes in L, US).

This species has the same coralloid fatiscent outgrowths (pl. 1) that characterize *P. flavotincta* Hale and *P. fasciculata* Vain. *Parmelia flavotincta* has a more membranous thallus and well-developed cilia. *Parmelia fasciculata* is very close except for chemistry. *Parmelia ramuscula* may have some relation to *P. cristifera* Tayl., a marginally sorediate species, in the same way that *P. fasciculata* is related to *P. dilatata* Vain.

Additional specimen examined:

PHILIPPINES: Rizal, Luzon, *Ramos* s.n. (H).

24 Parmelia rubifaciens Hale, sp. nov. PLATE 4

Thallus adnatus, 8–12 cm. diametro, viridi-glaucescens (in herbario olivaceo-glaucescens), lobis rotundatis, 5–8 mm. latis, margine sorediatis, soraliis plus minusve conglutinatis, partim submarginalibus, ciliis destitutis, superne opacus, rarius rugulosus et demum irregulariter rimosus, strato corticeo superiore 20 μ crasso, molli, strato gonidiali 20–25 μ crasso, medulla alba, 100–110 μ crassa, strato corticeo inferiore 12–18 μ crasso, inferne niger, sparse rhizinosus, versus ambitum castaneus, late nudus. Apothecia et pycnidia ignota. Thallus K+ flavescens; medulla K+ rubescens, C−, KC−, P+ aurantiaca vel lutea, atranorinum et acidum norsticticum continens.

Type in the Chicago Natural History Museum, collected in the vicinity of Casa Colorado, near El Crucero, summit of Sierra Managua, elev. 800–900 m., Managua, Nicaragua, May 14–25, 1947, by P. C. Standley (no. 8409; isotype in US).

Parmelia rubifaciens externally resembles *P. praesorediosa* Nyl. The soredia of *P. rubifaciens* however are somewhat more extensive, in part submarginal, and often become conglutinated in dense clumps. This species may be related to *P. crassescens* Stirt., a nonsorediate species which also contains norstictic acid, but the collections seen so far are smaller and more adnate than those of *P. crassescens*.

Additional specimens examined:

MEXICO: Veracruz: 24 km. northwest of San Andres Tuxtla, *Hale* 19777 (US); Yucatán: Tekax, *Gaumer* 1210d (F). GUATEMALA: Petén: La Libertad, *Lundell* 2237 (MICH); Zacapa: Gualán, *Kellerman*, Jan. 3, 1906 (OS, US).

BRAZIL: Minas Gerais: No locality, *Burchell* 1105 (K).

25. Parmelia saccatiloba Tayl. London Journ. Bot. 6:174. 1847.

Parmelia tinctorum var. *inactiva* Zahlbr. Denkschr. Akad. Wiss. Naturw. Wien 81:271. 1908. Type collection: Malifa, Upolu, Western Samoa, *Rechinger* 4999 (W, lectotype).

P. inactiva (Zahlbr.) Vain. Bot. Mag. Tokyo 35:47. 1921.

Type collection: Pitcairn's Island, *Beechey* (FH–Tayl, lectotype; H, isotype).

Thallus large, loosely attached on bark, 8–15 cm. broad, mineral gray to buff; lobes broad and rotund, 10–20 mm. wide, older lobes broadly convoluted and saccate, margins smooth, cilia lacking; upper surface dull, reticulately cracked with age, moderately isidiate, isidia cylindrical, simple to branched, 0.03–0.08 mm. in diameter, 0.1–0.3 mm. high; lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia adnate, 5–8 mm. in diameter, disc imperforate; hymenium 110–130 μ high; spores 12–16 $\times$22–26 μ, episporium 2.5–3.0 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

The other syntypes listed by Taylor (Mauritius, *Wright*, FH–Tayl; Brazil, *Hook. Herb.*, BM) are *P. tinctorum* Nyl., a common pantropical species with lecanoric acid.

The name *P. saccatiloba* has only rarely been correctly used in the literature. Nylander (1885) reported that it was the same as *P. zollingeri* Hepp, a nonisidiate species. Vainio (1890) conceived of it as a nonsorediate form of *P. dilatata* Vain. Lynge (1913) was misled by these erroneous concepts and identified *P. mesotropa* Müll. Arg. as *P. saccatiloba*. The lectotype of *P. saccatiloba* is actually an isidiate plant, very similar externally to *P. tinctorum* Nyl. but with tall thin cylindrical isidia and different chemistry. *Parmelia*

peralbida Hale from tropical America has similar chemistry but a thinner thallus and smaller spores. *Parmelia saccatiloba* is apparently restricted to the South Pacific.

Additional specimens examined:

HENDERSON ISLAND: North end, *St. John & Fosberg* 15103 (BISH). FIJI: Ovalau Island, *Herre* 5719 (LD). MARSHALL ISLANDS: Arno Atoll, *Horwitz* 9102C (US).

26. Parmelia setchellii Vain. Univ. Calif. Publ. Bot. 12:5. 1924.

Type collection: Puadruu, Tahiti, *Setchell & Parks* (TUR, Vainio herb. no. 2456, holotype).

Thallus loosely adnate on bark, 4–8 cm. in diameter, mineral gray; lobes rotund, often becoming crowded, 5–9 mm. wide, margins crenate, cilia lacking; upper surface plane, often faintly maculate, faintly white reticulate at the tips, finely reticulately cracked with age, coarsely pustulate or isidiate-pustulate in a broad marginal zone, pustules to 0.3 mm. thick, breaking open but not becoming sorediate; lower side black and rhizinate, light tan, shiny, and naked in a distinct but narrow zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

This unique species is known only from the type collection. It is characterized by peculiar inflated isidia which often break open and erupt as pustules but do not become sorediate. The lower side has a relatively narrow bare zone. Further collections are needed before we can ascertain the range of variation and its relation to other species.

27. Parmelia soyauxii Müll. Arg. Linnaea 9:32. 1880.

Parmelia nitens Müll. Arg. Bot. Jahrb. Engler 20:255. 1894. Type collection: Bukoba, Seen region, Tanganyika, Africa, *Stuhlmann* 4[095] (G, holotype; BM, isotype).

Type collection: Pungo Andongo, Angola, *Soyaux* 246 (G, holotype).

Thallus saxicolous, adnate, 6–12 cm. across, whitish to ashy mineral gray; lobes rotund, 6–9 mm. wide, soon crowded and more or less imbricate toward the center, margins entire to crenate, cilia lacking; upper surface shiny at the tips, continuous or becoming cracked with age and darkening from superficial fungal infestations; lower side black and moderately rhizinate, dark brown and naked in a broad zone along the margins. Apothecia adnate to substipitate, amphithecium dull, disc usually perforate; hymenium 65–75 μ high; spores 5–7$\times$12–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ deep red, KC+ deep red, P—, atranorine and lecanoric acid present.

Parmelia soyauxii is a saxicolous species apparently most common in the dry savannas of western Africa. The thallus is ashy white, externally similar to *P. breviciliata* Hale, another saxicolous species with alectoronic acid and cilia. The sorediate counterpart of *P. soyauxii* is *P. defecta* Hale.

Additional specimens examined:

ANGOLA: Morro de Lopollo, *Welwitsch* 25 (BM); above Sá da Bandeira, *Degelius*, Feb. 6, 1960 (DEGEL); between Sá da Bandeira and Vila Arriaga, Huila, *Degelius*, Feb. 3, 1960 (DEGEL). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH). MADAGASCAR: Mandruka, *Lemaitre* (H).

28. Parmelia tinctorum Nyl. Flora 55:547. 1872.

Parmelia latissima Fée f. *isidiosa* Müll. Arg. Linnaea 43:32. 1880. Type collection: Near Mayumba, mouth of Banya River, Gabon, Africa, *Pechuel-Loesche* (G, lectotype).

P. praetervisa Müll. Arg. Flora 63:276. 1880. Type collection: Java, *Zollinger* 449b (G, lectotype).

P. perlata var. *platyloba* Müll. Arg. Flora 65:316. 1882. Type collection: Japan, *Brauns* 5 (G, lectotype).

P. meiosperma var. *ecklonii* Dodge, Ann. Mo. Bot. Gard. 46:141. 1959. Type collection: Cape of Good Hope, Africa, *Ecklon* (FH–Tuck, holotype).

Type collection: Canary Islands, *Dèspréaux* (?) (H, holotype).

Thallus large, 8–20 cm. broad, loosely adnate on rock or bark, whitish mineral gray; lobes rotund, 10–15 mm. wide, margins entire, cilia lacking; upper surface plane, dull, densely isidiate, isidia papillate-granular to cylindrical, coarse, 0.06–0.10 mm. in diameter, to 2 mm. high, simple to rarely coralloid-branched; lower side black and sparsely rhizinate at the center, brown, shiny, and naked in a broad zone at the margins. Apothecia very rare, to 20 mm. in diameter, exciple isidiate-dentate, amphithecium rugose, white-maculate, isidiate, disc imperforate; hymenium 55–65 μ high; spores 7–10×13–15 μ, episporium 1.5 μ thick; pycnidia rare, conidia 12–15 μ long.

Reactions: Thallus K+ yellow; medulla K−, C+ blood red, KC+ red, P−, atranorine and lecanoric acid present.

This common weedy pantropical species is well known to all lichenologists. It is immediately identified by the brilliant C+ red reaction and by the simple often granular or papillate isidia. Vainio (1890) recognized this species as *P. coralloidea* (Mey. & Flot.) Vain. in preference to *P. tinctorum*, apparently because he used the concept of absolute priority. The name is illegitimate and, furthermore, a type fragment of *P. perlata* var. *coralloidea* Mey. & Flot. at Geneva seems to be a *Hypotrachyna* species, though too small for study. As Hillmann reported (1939), this specimen is C−.

Additional representative collections examined:

U.S.: KENTUCKY: 8 mi. northwest of Brownsville, Edmonson Co., *Hale* 13861 (US); VIRGINIA: Amburg, Middlesex Co., *Luttrell* 1709 (MO); NORTH CAROLINA:

Smith Island, *Morton* 2219 (US); between Atlantic Beach and Salterpath, Carteret Co., *Culberson* 6846 (DUKE, US); SOUTH CAROLINA: Beaufort, Beaufort Co., *Hale* 7622 (US); 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16548 (US); Isle of Palms, Charleston Co., *Culberson* 9041 (DUKE, US); TENNESSEE: Sycamore, Cheatham Co., *Phillips* s.n. (US); GEORGIA: 3 mi. southwest of Hinesville, Liberty Co., *Hale* 16757 (US); 5 mi. southwest of Waycross, Ware Co., *Hale* 16826 (US); FLORIDA: 5 mi. east of Greenville, Madison Co., *Hale* 17616 (US); 8 mi. east of Ocala, Marion Co., *Hale* 17032 (US); northwest of Hilliard, Nassau Co., *Hale* 17623 (US); Tomoka State Park, Volusia Co., *Hale* 17068 (US); Sanford, Seminole Co., *Rapp, Merr. Lich. Exs.* 141 (BM, M, US); Indian River City, Brevard Co., *Degelius* s.n. (DEGEL, US); Crewsville, Hardee Co., *Hale* 16875 (US); near Pensacola, Escambia Co., *Hale* 7996 (US); ALABAMA: Oak Mountain Park, Shelby Co., *Hale* 7123 (US); Dothan, Houston Co., *McLennan* 6002002 (US); Pocosin, Pike Co., *McCullough* 467 (US); near Epps, Sumter Co., *McCullough* 627 (US); Wilmer, Mobile Co., *Hale* 7174 (US); MISSISSIPPI: Lucedale, George Co., *Hale* 7782 (US); Collins, Covington Co., *Hale* 7971 (US); Tupelo, Lee Co., *Hale* 7808 (US); LOUISIANA: 22 mi. south of New Orleans, Plaquemines Parish, *Smith* 12392 (US); Jefferson Island, Iberia Parish, *Drouet* 9059 (F); Lake Charles, Calcasien Parish, *Drouet* 8743 (F); St. Martinsville, Martin Parish, *Langlois, Lich. Bor.-Amer.* 122 (H, M, MO, US), *Decades N. A. Lich.* 190 (BM, DUKE, US); ARKANSAS: Near Dallas, Polk Co., *Hale* 3941 (US); TEXAS: 7 mi. south of Silsbee, Hardin Co., *Whitehouse* 25955 (MO); near Avinger, Cass Co., *Hale* 5264 (US); near Woodville, Tyler Co., *Hale* 5226 (US); Karnack, Harrison Co., *Hale* 5324 (US); Nacogdoches, Nacogdoches Co., *Hale* 5435 (US). MEXICO: TAMAULIPAS: Between Mante and Antiguo Morelos, *Moore* 3636 (US); JALISCO: San Sebastian, *Mexia* 1541b (F); VERACRUZ: 96 km. east of Córdoba, *Hale* 19722 (COLO, LISU, MSC, US); Teocello Canyon, south of Xico, *Hale* 21163 (US); PUEBLA: St. Barbara, *Arsène* 808 (US); OAXACA: Km. 686 on highway 190, *Hale* 20647 (MSC, REN, US); CHIAPAS: south of Teopisca, *Hale* 20520 (S, TNS, US); El Sumidero, Tuxtla Gutiérrez, *Hale* 21210 (US); YUCATÁN: Chichankanab, *Gaumer* 2255 (F); Tekax, *Gaumer* 1210 (F). GUATEMALA: SACATEPÉQUEZ: Near Antigua, *Standley* 58822 (F). HONDURAS: COMAYAGUA: Siguatepeque, *Yuncker et al.* 6460 (F, MO), *Standley & Chacon* 6773 (F); MORAZÁN: El Zamorano, *Standley* 241, 12275 (F). BRITISH HONDURAS: EL CAYO: Cohune Ridge, *Mains* 3828 (MICH). EL SALVADOR: SAN VICENTE: Vicinity of San Vicente, *Standley* 3662 (F). NICARAGUA: JINOTEGA: Sierra west of Jinotega, *Standley* 10267 (F); CHONTALES: La Libertad, *Standley* 8789 (F). COSTA RICA: GUANACASTE: Tilarán, *Standley* 44476 (US); ALAJUELA: Cerros de Pata de Gallo, *Brenes* 222 (MICH); CARTAGO: North of Cartago, *Standley* 49590, 49631 (US). PANAMA: Chiriquí, *Wagner* 334 (M).

BERMUDA: Devonshire Marsh, *Britton* 167 (FH, NY). CUBA: PINAR DEL RÍO: Northwest of Hotel San Vicente, *Imshaug* 25232 (MSC, US); Sierra de los Organos, *Imshaug* 25375 (MSC, US); ORIENTE: El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24735 (MSC); Guantánamo, *Hioram* 18090 (M); Puerto Boniato Ridge, Santiago de Cuba, *Imshaug* 24661 (MSC). HAITI: Northwest of Jacmel, *Thomas* 66 (NY, US); west of Cap Haitien, *Imshaug* 22679 (MSC); below Citadelle, south of Milot, *Wetmore* 2849 (MSC); St. Michel de l'Atalaye, *Leonard* 8015a (FH, NY, US). DOMINICAN REPUBLIC: East of La Romana, *Hassler* 1330 (WIS); Ciudad Trujillo, Santo Domingo, *Allard* 15709, 16182, 17012 (US); Santiago, *Imshaug* 23800 (MSC, US); Gauma, *Wetmore* 3905 (MSC); Los Amaceyes, Cordillera Setentrional, *Wetmore* 3378 (MSC, US); Sousa Bay, Puerto Plata, *Wetmore* 3952 (MSC, US); without locality, *Raunkiaer* 495 (C).

JAMAICA: Flora River, St. Andrews, *Imshaug* 14401 (MSC, US); Albion, St. Ann, *Imshaug* 15896 (MSC), 15920 (MSC, US); Birches Hill, Hanover, *Imshaug* 15673 (MSC); summit of Montpelier, St. Catherine, *Imshaug* 14298 (MSC); Bulls Head, Clarendon, *Bengry* 334 (PH): New Market, *Britton* 534 (FH). PUERTO RICO: 7 mi. south of Caguas, *Heller* 308 (FH, NY); Lares to San Sebastian, *Britton* 2789 (NY); El Río, *Goll* 307 (US); Naranjito, *Fink* 295 (NY); Adjuntas, *Sintenis* 79 (M, NY), 87 (G); near Aibonito, *Sintenis* 55 p.p. (G); Mt. Morales, *Britton* 841 (FH, NY). U.S. VIRGIN ISLANDS: St. Thomas: Crown, *Raunkiaer* 415 (C); Signalhill, *Eggers* s.n. (FH); St. John: Bordeux, *Britton* 567 (FH, NY), *Raunkiaer* 402 (C). BRITISH VIRGIN ISLANDS: Virgin Gorda, *Fishlock* 324 (FH, NY); Tortola, *Eggers* 3192 (C). TRINIDAD: Port of Spain, *Degelius*, June 17, 1958 (DEGEL).

VENEZUELA: Guarico: Between Uberito and Los Placeres, *Pittier* 12395 (US); Federal Distr.: Caracas, *Vogl* s.n. (M), *Dennis* 1516, 1519 (K); Maracay, *Mägdefrau* 401 (M). COLOMBIA: Santander: Between El Roble and Tona, *Killip & Smith* 19445 (US); Mesa de los Santos, *Killip & Smith* 15148 (US). GALÁPAGOS ISLANDS: Santa Maria Isl., *Taylor* 864 (MO). PERU: San Martín: Tingo María, *Allard* 21600, 22577 (US); Cuzco: Valle de Lacco, *Herrera* 2070 (US). BRAZIL: Minas Gerais: Viçosa Agricultural College, *Mexia* 5145a (US); Sitio, *Vainio, Lich. Bras. Exs.* 1082 (M), 614 (UPS); Rio de Janeiro: Rio de Janeiro, *Copeland* 2 (G), *Darwin* 463 (K); Mato Grosso: Near Santa Cruz, *Moore* 719 (BM); Santa Anna da Chapada, *Malme. Lich. Austroamer.* 81 (H, LD, UPS); São Paulo: Near Santos, *Schiffner* s.n. (M); Cruzeiro, *Robert* s.n. (BM). PARAGUAY: Cerro Negro, Paraguari, *Malme* 1480 (LD). ARGENTINA: Without locality: *Lorentz & Hieronymus* (M); Jujuy: Laguna de la Brea, Chaco, *Fries* 43a (S); Salta: Urundel, Orán, *Grassi* 5642 (MO); northwest of Urundel, *Killip* 39624 (US); Misiones: San Ignacio Gisela, *Montes* 36 (LD); without locality, *Borman* s.n. (MO).

CANARY ISLANDS: La Palma, *Bornmüller* 3283 (LD); Puerto de la Cruz, Tenerife, *Deglius*, Jan. 21, 1960 (DEGEL). IVORY COAST: Danane, cercle of Man, *Santesson* 10491a (UPS); Mt. Orombo-Boka, cercle of Dimbokro, *Santesson* 10724c (UPS). GUINEA: Mont Nimba, N'Zérékoré, *Santesson* 10515 (UPS). REPUBLIC OF CONGO: Brazzaville, *Degelius* s.n. (DEGEL). CONGO: South of Albertville, *Höeg* s.n. (TRH); Kabalo, Katanga, *Höeg* s.n. (TRH); Victoria Falls, *Höeg* s.n. (TRH); southwest side of Lake Kivu, *Degelius* s.n. (DEGEL). ANGOLA: Moxico: Between Luso and Cachipoque, *Degelius* s.n. (DEGEL, US); Bié: Chinguar, *Degelius* s.n. (DEGEL); Malanje: Duque de Bragança, *Degelius* s.n. (DEGEL); Cuanza-Sul: 10 km. north of Cassonque, *Degelius* s.n. (DEGEL); Huila: North of Quilengues, *Degelius* s.n. (DEGEL). MOÇAMBIQUE: 3 km. north of Vila Luiza, Lourenço Marques, *Almborn* 6886 (LD). SOUTHERN RHODESIA: Matopo Hills, *Eyles* 1178 (BM); south of Felixburg Station, *Höeg* s.n. (TRH); between Cashel and Melsetler, *Schelpe* 4046 (BM). UNION OF SOUTH AFRICA: Transvaal: 2 mi. north of Warmbad, Waterberg, *Almborn* 5895 (LD); near Punch Bowl, Zoutpansberg, *Almborn* 6332, 6487 (LD); Natal: Boschfontein forest, Lions River Distr., *Almborn* 8677 (LD); Eschowe, *Almborn* 8492 (LD, US); Pietermaritzburg, *Almborn* 9629 (LD, US); Nottingham, *Clouston* 1564 (PRE); Cape Province: Near Port Elizabeth, *Höeg* s.n. (TRH); Grahamstown, Albany, *Höeg* s.n. (TRH). MADAGASCAR: Mantasoa, *Decary* s.n. (P); Fort Dauphin, *Elliott* 2862 (BM).

NEPAL: Langtang Khola, *Polunin* M161 (BM). INDIA: Darjeeling, Himalayas, *Awasthi* 3874 (AWAS); Shembagar, Palni Hills, *Awasthi* 4089 (AWAS). THAILAND: Doi Chieng Dao, *Tsuyama* 14 (TNS); Pha Nok Kao, Loei, *P.S.*

(K); LAOS: Hase Plantations, *Tsuyama* 15, 22 (TNS). CHINA: Tien Tai Shan, Chekiang Prov., *Chiao* 14065 (US); Chihli Prov., *Clemens* 4014 (US). HONG KONG: *Wright* s.n. (US). JAPAN: Otani, Prov. Inaba, *Ikoma* 6228 (LD); near Mito, Ibaraki, *Sato, Lich. Jap.* 10 (LD); Ono, Koga, Omi Prov., *Kurokawa* 520026 (LD, TNS, US); Shakudai, Shimamoto, Prov. Settu, *Kurokawa* 57253 (TNS, US).

SUMATRA: Kebondjahe, *Depari* 4 (BO); Brastagi, *Breedveld* 21 (BO); Mt. Marapi, *Groenhart* 9152 (BO). JAVA: Kampong Koebang, *Neervoort* 2181 (BO); Tjibodas, *Neervoort* 41 p.p. (BO). BALI: Batoer, *De Voogd* s.n. (BO). NEW GUINEA: Nondugl, Western Highlands Distr., *Hoogland* 3194 p.p. (BM). GUAM: Agana, *Necker* 301 (US). MARSHALL ISLANDS: Inc Island, Arno Atoll, *Stone* 1120 (US). NEW HEBRIDES: Hog Harbor, *Baker* s.n. (BM). AUSTRAL ISLANDS: Naa Rurutu, *Fosberg* 12003 (BISH, MO). MANGAREVA ISLAND: Near Atituiti Point, *Fosberg* 11112 (BISH, MO, US); Mt. Duff, *St. John* 14489 (MO). SAMOA: Upolu, *Reinecke* 13 (BO, US). TAHITI: Papeari, *Herre* s.n. (LD, MICH). HAWAIIAN ISLANDS: KAUAI: Waiakale, *Faurie* 75 bis (BM). AUSTRALIA: Sydney, New South Wales, *Home* s.n. (BM).

29. Parmelia zollingeri Hepp *in* Zoll. Syst. Verz. 9. 1854. PLATE 6

Parmelia latissima var. *corniculata* Kremplh. Flora 61:463. 1878. Type collection: Cionega, Argentina, *Lorentz & Hieronymus* (M, holotype).

P. neocaledonica Nyl. Flora 68:609. 1885. Type collection: New Caledonia, *Vieillard* (H, Nyl. herb. no. 35304, holotype).

P. platyphyllina Vain. Hedwigia 46:168. 1907. Koh Chang, Thailand, *Schmidt* XXX (TUR, holotype; C, isotype).

P. latissima var. *minima* Lynge, Ark. Bot. 13, no. 13:45. 1914. Type collection: Buriti, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2243C** (S, holotype).

P. bogoriensis Zahlbr. Ann. Crypt. Exot. 1:206. 1928. Type collection: Buitenzorg Garden Java, *Overeem* 4 (W, holotype; BO, MICH, isotypes).

P. overeemii Zahlbr. Ann. Crypt. Exot. 1:204. 1928. Type collection: Mt. Tjibodas, Java, *Overeem* 94 (W, holotype; BO, isotype).

P. litoralis Dodge, Ann. Mo. Bot. Gard. 46:169. 1959. Type collection: Kilifi, Kenya, Africa, *Matt Cass*, September 1939 (K, holotype).

P. robertyi Dodge, Ann. Mo. Bot. Gard. 46:174. 1959. Type collection: Bouallé, Boka de Titièkro, Ivory Coast, *G. Roberty* 13941 (G, holotype).

Type collection: Bantam, Java, *Zollinger* 1241 (L, holotype; G, H, isotypes).

Thallus loosely adnate to bark, 10–20 cm. broad, olivaceous mineral gray; lobes broad and rotund, 15–18 mm. wide, margins entire or lobulate or sublobulate, frequently short ciliate in the axils of lobes, cilia 0.5–0.8 mm. long, sometimes branched; upper surface smooth, irregularly cracked with age, dull, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, brown and naked in a broad zone at the margins. Apothecia common, 3–10 mm. in diameter, substipitate, amphithecium smooth, disc imperforate; hymenium 70–80 μ high; spores 7–10×18–22 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia 8–10 μ long.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia zollingeri is a variable widespread pantropical species. Externally it is extremely close to *P. latissima* Fée, which differs principally in chemistry (K+ red, salacinic acid) and larger spores (28–32 μ long). Most specimens of *P. zollingeri* from tropical America lack cilia, but specimens from Asia often have more or less distinct axial cilia, up to 0.8 mm. long. We are, however, classifying *P. zollingeri* among the nonciliate species. Another area of variability is the development of marginal laciniae which may be richly developed, as in *P. latissima* var. *corniculata* Krempl h., to completely absent. Variability in the development of both cilia and laciniae is largely continuous and extremely difficult to classify. The only other species that can be compared with *P. zollingeri* is *P. disparilis* Nyl., which has laciniate lobes and apothecia, maculae, and somewhat smaller spores.

Additional specimens examined:

U.S.: FLORIDA: Watson Hammock, Big Pine Key, Monroe Co., *Killip* 40869 (US); Royal Palm Hammock, Dade Co., *Small* 7581 (US); Snapper Hammock, subtropical Florida, *Britton* 408 (NY, US). MEXICO: VERACRUZ: 7 km. north of Fortín de las Flores, *Hale* 19671 (US); Mirador, *Ross* 625 (M); CHIAPAS: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20186 (COLO, DUKE, LISU, MSC, REN, S, TNS, US); Km. 916 on highway 190, west of Ocozocoautla, *Hale* 20600 (TNS, US); CAMPECHE: Calahmul, *Lundell* 1172 (F). GUATEMALA: PETÉN: La Libertad, *Lundell* 2237 (F); ALTA VERAPAZ: Between San Cristóbal and Verapaz, *Steyermark* 43881 (MO). HONDURAS: COMAYAGUA: Near Siguatepeque, *Yuncker* 6499 (US); ATLÁNTIDA: Near Tela, *Standley* 55431 (F). BRITISH HONDURAS: Belize River, *Lundell* 1824 (MICH). COSTA RICA: GUANACASTE: Los Ayotes, near Tilarán, *Standley* 45522 (US); Mt. Irazú, *Bruner* 9504 (MO).

BAHAMAS: New Providence, *Britton* 646 bis (NY); Watlings Island, *Britton* 6205, 6217 (FH, NY); Abaco, *Brace* 1983 (FH, NY). GRAND CAYMAN: Ironshore Area, Spotts Beach, *Imshaug* 24585 (MSC, US); near Georgetown, *Imshaug* 24398 (MSC, US). CUBA: Without locality, *Sagra* in 1836 (UPS); CAMAGUEY: La Gloria, *Shafer* 767 (FH); PINAR DEL RIO: San Diego de los Baños, *Leon* 5260 (FH); northwest of Hotel San Vicente, *Imshaug* 25245 (MSC, US); ORIENTE: Antilla, *Britton* 12523 (FH). HAITI: Furcy, *Leonard* (FH). DOMINICAN REPUBLIC: Sousa Bay, Puerto Plata, *Wetmore* 3926 (MSC). JAMAICA: Without locality, *Wright* s.n. (K), Newcastle, *Cushman* 168 (FH); Morces Gap, Blue Mountains, *Imshaug* 13295 (MSC), Dunns River, St. Ann, *Imshaug* 15753 (MSC, US).

VENEZUELA: BOLÍVAR: Salto de Auraima, Río Paragua, *Killip* 37371b (US). COLOMBIA: NORTE DE SANTANDER: Alto de Santa Inés, *Cuatrecasas* 12451 (US). PERU: CUZCO: Valle de Lacco, *Herrera* 2071 (US); Machupicchu, *Herrera* 3263 (US); LORETO: Mishuyacu, *Klug* 1108 (US). BRAZIL: Santarém, *Spruce* 112 (K). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

MAURITIUS: *McGregor* s.n. (BM). LAOS: Hase Plantations, *Tsuyama* 6, 16 (TNS). FORMOSA: Kuraru, *Asahina* s.n. (TNS, US). JAVA: Without locality, *Horsfield* s.n. (BM); vicinity of Goenoeng Boender, *Palmer* 611 (US). PHILIPPINES: Mt. Malinao, Luzon, *Edaño* 37206 (K). TONGA: EUA: Fuai plantation, *Yuncker* 15302 (US).

2. Section *Subflavescentes* (Vain.) Gyel. (1932, p. 225)

Section *Amphigymnia** *Subflavescens* Vain. (1890, p. 35)
Section *Amphigymnia* subsection *Subflavescentes* (Vain.) Hillm. (1934, p. 234).

Type species: *Parmelia delicatula* Vain.

Thallus as in section *Amphigymnia* except margins and apices of lobes distinctly ciliate.

Subsection *Subflavescentes*

This subsection may be divided into two series: *Subflavescentes* with usnic acid and *Emaculatae* (p. 277) without usnic acid.

Series *Subflavescentes*

Thallus yellowish green, usnic acid present; lower side dark brown along the margins; apothecia imperforate.

This small series corresponds exactly to Vainio's original group *Subflavescentes*. All of the species contain usnic acid in abundance. Except for the pantropical *P. xanthina* and the African endemic *P. ochroglauca*, the species occur chiefly in tropical and subtropical America.

30. Parmelia aberrans (Vain.) des Abbayes, Bull. Inst. Fr. Afr. Noire, ser. A, 20:22. 1959.

Parmelia xanthina f. *aberrans* Vain. Ann. Acad. Soc. Faun. Fl. Fenn. 7, no. 7:37. 1890.

P. xanthina var. *ciliata* Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:175. 1909. Type collection: Mt. Jaraguá, near Taipas, São Paulo, Brazil, *Schiffner*, June 1901 (WU, holotype).

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 664 (TUR, Vain. herb. no. 2758, holotype).

Thallus large, loosely attached on bark or humus, yellowish green, 10–15 cm. in diameter; lobes rotund, 10–15 mm. wide, margins broadly crenate to isidiate-dissected on older lobes, ciliate, cilia 1.0–3.0 mm. long; upper surface dull to shiny, smooth to minutely rugulose and finely reticulately cracked on older lobes, isidiate, especially in a zone near the margins, isidia simple to coralloid-branched and sometimes apically ciliate, isidia 0.04–0.06 mm. in diameter, to 0.6 mm. high; lower side black, moderately rhizinate, dark brown and naked in a broad zone at the margins. Apothecia very short-stalked, 2–4 mm. in diameter, amphithecium rugose, isidiate, disc imperforate; hymenium 65–75 μ high; spores 7–10×10–16 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K−, C+ rose, KC+ deep red, P−, atranorine, usnic acid, and gyrophoric acid present.

In his original description Vainio gives the diagnostic color test as "Medulla $CaCl_2O_2$ non reagens." The holotype specimen however is clearly C+ rose and contains gyrophoric acid. Since the holotype takes precedence over the description, *P. aberrans* must be regarded as C+. The C— population is *P. xanthina* (Vain.) Müll. Arg. Des Abbayes (1958) followed Vainio's description when elevating f. *aberrans* to species rank and considered it to be C— and *P. xanthina* to be C+, a concept thus the opposite of ours. *Parmelia aberrans* is morphologically indistinguishable from *P. xanthina* (including *P. madagascariacea*) but has a more restricted distribution, known so far only in tropical America (see fig. 12).

Additional specimens examined:

MEXICO: CHIAPAS: Hacienda, *Matuda* s.n. (MICH); 8 km. east of Teopisca, *Hale* 20355 (DUKE, S, TNS, US). GUATEMALA: ZACAPA: Between Santa Rosalia and San Lorenzo, *Steyermark* 43179 (MO, US). COSTA RICA: GUANACASTE: Hacienda Santa María, *Dodge* 6708 (S). PANAMA: CHIRIQUÍ: Chiriquí, *Wagner* s.n. (M).

PERU: No locality, *Mathews* s.n. (BM). BRAZIL: MINAS GERAIS: Caraça, *Vainio, Lich. Bras. Exs.* 1181 (BM, M, TUR, UPS); RIO DE JANEIRO: Serra dos Orgãos, *Burchell* 2305 (K); MATO GROSSO: Bocca da Serra, *Malme* 2748 (S, UPS); Santa Anna da Chapada, *Malme* s.n. (S). PARAGUAY: No locality, *Grosse* s.n. (MO).

31. Parmelia conformata Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:36. 1890.

Parmelia conformata f. *ciliolifera* Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:36. 1890. Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 615 (TUR, Vain. herb. no. 2489, holotype; BM, isotype).

P. xanthina var. *subeciliata* Müll. Arg. Hedwigia 30:228. 1892. Based on *P. conformata* Vain.

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 650 (TUR, Vain. herb. no. 2485, lectotype; FH, M, isotypes).

Thallus adnate, 6–10 cm. in diameter, yellowish green; lobes rotund, 7–10 mm. wide, margins entire to dentate or incised toward the center, sparsely ciliate, cilia 0.5–1.0 mm. long; upper surface plane, continuous or reticulately cracked with age, faintly white-reticulate at the tips, densely isidiate, isidia simple to branched, 0.04–0.07 mm. in diameter, 0.3–0.6 mm. high; lower side black and sparsely rhizinate in the center, brown and naked in a broad zone at the margins. Apothecia very rare, more or less pedicellate, amphithecium isidiate, disc imperforate; hymenium 50–60 μ high; spores 9–11×18–25 μ, episporium 1.5–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla P+ red, K+ brown, C— atranorine, usnic, protocetraric, and fumarprotocetraric acids present.

Parmelia conformata superficially resembles the other yellow isidiate species *P. xanthina* (Müll. Arg.) Vain. and *P. flavescens* (Kremplh.) Nyl. It differs in chemical constituents, larger spores, and sparse

development of cilia. Vainio recognized a specimen with more conspicuous cilia as f. *ciliolifera* but this form has no taxonomic significance. Except for one locality in Africa, *P. conformata* is a tropical American species most common in pine forests at higher elevations in the West Indies.

Vainio listed as a synonym *P. caperata* f. *isidiosa* Müll. Arg. The type of this taxon (G) is a fragment that I tentatively identify as *P. cinerascens* Lynge, a *Hypotrachyna* species. Vainio supplied spore data for *P. conformata* from this specimen, but since Müller's plant is a different species, these spore data should be ignored.

Additional specimens examined:

MEXICO: Chiapas: 18 km. S.E. of San Cristóbal, *Hale* 20296 (US); 50 km. west of Tuxtla Gutiérrez, *Hale* 19930 (US); 40 km. southeast of Comitán, *Hale* 20477 (US). PANAMA: Chiriquí: Chiriquí, *Scholander*, February 1941 (MO, US).

HAITI: Mission, Fonds Varettes, *Leonard* 3887 (FH); summit of Montagne Noire, near Kenscoff, *Wetmore* 2767 (MSC); west of Forêt des Pins, *Wetmore* 3202 (MCS); summit ridge on Tête Etang, *Wetmore* 2659 (MSC). DOMINICAN REPUBLIC: Valle Nuevo, Constanza, La Vega, *Allard* 16540a, 16562b, 16582b, 17678 (US); Cerrazo, ridge from La Cumbre to Santiago, *Wetmore* 3842 (MSC); north side of Constanza, Cordillera Central, *Imshaug* 23722 (MSC). JAMAICA: Albion, St. Ann, *Imshaug* 15906 (MCS); Dolphin Head, Hanover, *Imshaug* 15652 (MSC); Cooper's Hill, Red Hills, St. Andrew, *Imshaug* 14156 (MSC).

BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 538b (K, TUR), 650b (UPS), 981 (TUR).

ANGOLA: Huila: Above Sá da Bandeira, Humpala Plateau, *Degelius*, Feb. 6, 1960 (DEGEL, US).

32. Parmelia delicatula Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:35. 1890.

Parmelia subcaperata f. *ciliata* Zahlbr. Bull. Herb. Boiss., II, 4:135. 1904. Type collection: Morro de São Sebastião, Brazil, *Damazio* 940 (W, holotype; G, isotype).

P. magna Lynge, Ark. Bot. 13, no. 13:83. 1914. Type collection: São João d'el Rey, Minas Gerais, Brazil, *Malme* 269 (S, holotype; LD, MO, UPS, isotypes).

P. radians Lynge, Ark. Bot. 13, no. 13:85. 1914. Type collection: São João d'el Rey, Minas Gerais, Brazil, *Malme* 203 (S, holotype; MO, isotype).

Parmelia microdactyla Hale, Contr. U.S. Nat. Herb. 36, part 1:21. 1960. Type collection: Rio de Janeiro, Brazil, *Widgren* (UPS, holotype; S, isotype).

Type collection: Caraça, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 1256 (TUR, Vain. herb. no. 2754, holotype; BM, FH, M, UPS, isotypes).

Thallus saxicolous, 5–15 cm. in diameter, yellowish green; lobes very variable, from rotund and monophyllous to rather narrow and subimbricate, 5–15 mm. wide, margins adnate to suberect, sparsely ciliate, cilia 1–2 mm. long; upper surface dull, often faintly white-pruinose, reticulately cracked with age, isidia and soredia lacking;

lower side black and moderately rhizinate, dark brown and naked in a zone along the margins. Apothecia adnate to substipitate, 4–10 mm. in diameter, disc imperforate; hymenium 55–75 μ high; pores 5–8$\times$10–14 μ, episporium 1 μ thick; pycnidia abundant, conidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine, usnic acid, and salacinic acid present.

Parmelia delicatula is a saxicolous species common in the area around Rio de Janeiro. The variability of the species is very great, as one can surmise from the number of synonyms. The basic characters are marginal cilia of varying development, lack of soredia and isidia, and presence of salacinic and usnic acids. The lobes may be broad and flattened, as in the type of *P. magna*, or rather narrow with ascending margins, as in the types of *P. delicatula* and *P. radians*. *Parmelia microdactyla*, first thought to be distinct because of the small marginal lobules, is apparently only a rare morphological variant.

Additional specimens examined:

BRAZIL: Paraná: Serrinha, *Dusén, Lich. Austroamer.* 85 (H, K, LD, MSC, S, UPS); Minas Gerais: Serra do Ouro Preto, *Damazio, Zahlbr. Lich. Rar. Exs.* 80 (BPI, FH, UPS); Serra de Caldas, *Mosén* 2318a, b (S). URUGUAY: Rocha: Estancia Cerros, *Hosseus* 111 (H).

33. Parmelia flavescens (Krempl.) Nyl. Flora 68:607. 1885. Plate 11

Parmelia glaberrima β flavescens Krempl. Flora 52:223. 1869.

P. glaberrima f. *flavescens* (Krempl.) Krempl. Flora 59:73. 1876.

P. latissima f. *flavescens* (Krempl.) Müll. Arg. Linnaea 43:37. 1880.

P. mauriensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:201. 1899. Type collection: Abrededores, San Luis de Potosí, Mexico, *Maury* 7651 (P, holotype).

P. protoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. Illegitimate name based on *P. glaberrima β flavescens* Krempl.

P. pseudoflavescens Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:176. 1909. *Nomen nudum.*

Type collection: Brazil, *Glaziou* 1833 (M, holotype; H, isotype).

Thallus saxicolous, expanded, up to 25 cm. broad, coriaceous, yellowish green; lobes rotund, 9–12 mm. wide, margins entire to lacerate or dissected, often isidiate, sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface opaque, reticulately cracked with age, moderately isidiate, isidia simple or sparingly branched, 0.06–0.1 mm. in diameter, to 0.6 mm. high, infrequently ciliate; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia common, to 10 mm. in diameter, amphithecium rugose, maculate, sparcely isidiate, disc imperforate or rarely perforate; hymenium 40–55 μ high; spores 6–8$\times$10–12 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow or more intensely yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine, usnic acid, and salacinic acid present.

Parmelia flavescens is typically a saxicolous species characterized by salacinic acid and isidia. All other isidiate yellow species contain K− substances and are usually corticolous. The apothecia of *P. flavescens* are adnate and most frequently imperforate, although rarely perforate.

The nomenclatorial confusion created by Zahlbruckner has already been discussed (Hale, 1960). The identity of *P. mauriensis* Hue and *P. flavescens* is interesting in that *P. mauriensis* was formerly thought to be a synonym of *P. subcrinita* Nyl., an isidiate species lacking usnic acid.

Additional specimens examined:

MEXICO: Isla Socorro, *Herrera* 18 (MSC). GUATEMALA: Jalapa: Hills northeast of Jalapa, *Standley* 76788 (MO, US); Jalapa, *Standley* 76530 (M). HONDURAS: Morazán: El Zamorano, *Standley & Williams* 465 (F, US), *Standley* 1691 (MO).

VENEZUELA: Between Caracas and La Guaira, west of Silla de Caracas, *Santesson* 6670 (S). COLOMBIA: Norte de Santander: Vicinity of Toledo, elev. 1700–1900 m., *Killip & Smith* 20514 (US); Cundinamarca: Bogotá, *Weir* 58 (BM, K); Antioquia: Medellín, *Charetier* 191 (US). BRAZIL: Rio de Janeiro: Serra dos Orgãos, *Burchell* 2385 (K).

34. Parmelia miranda Hale, sp. nov. Plate 11

Thallus late expansus, membranaceus vel rigidulus, usque ad 10 cm. latus, viridi-flavicans vel stramineo-albicans, lobis rotundatis, vage ramosis, margine sinuato-incisis, sorediatis, soraliis globosis vel elongatis, lobis sorediatis plus minusve involutis, ciliatis, ciliis inconspicuis, 0.5–2.0 mm. longis, superne laevigatus, opacus, demum leviter albo-pruinosus, continuus vel paulo rimosus in aetate, strato corticeo superiore 12–14 μ crasso, strato gonidiale 26–35 μ crasso, medulla alba 65–70 μ crassa, strato corticeo inferiori 13–15 μ crasso, inferne niger dense rhizinosus, rhizinis atris, nitidis, ambitu fusco-castaneus, late nudus. Apothecia ignota. Thallus K−; medulla K+ rubra, C−, KC−, P+ aurantiaca, acidum salacinicum et acidum usnicum continens.

Type in the U.S. National Herbarium, collected on pine-scrub oak mountainside, Km. 686 on Hwy. 190, northwest of Tehuantepec, Oaxaca, Mexico, Mar. 31, 1960, by M. E. Hale (no. 20653). (Isotypes in COLO, DUKE, LISU, MSC, REN, S, TNS).

Parmelia miranda is characterized by the large yellowish green thallus and marginal soralia and cilia. There are only two other comparable species in the subgenus *Amphigymnia*, *P. viridiflava*

Hale and *P. ochroglauca* Hale. *Parmelia viridiflava* is very close to *P. miranda* but differs in chemistry (protocetraric and fumarprotocetraric acids). *Parmelia ochroglauca*, an African species, has distinctly revolute sorediate lobes and contains protolichesteric acid. *Parmelia miranda* is endemic to Mexico where it occurs in open oak-pine forests.

Additional specimens examined:

MEXICO: OAXACA: 77 km. northwest of Tehuantepec at km. 719 on highway 190, *Hale* 20615 (US); CHIAPAS: 8 km. east of Teopisca, *Hale* 20346 (US); 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20165 (S, US).

35. Parmelia ochroglauca Hale, sp. nov.

Thallus laxe adnatus, 8–15 cm. diametro, obscure viridiflavus, lobis rotundatis, 8–12 mm. latis, margine subcrenatis, ciliatis, ciliis 0.5–1.5 mm. longis, sorediatis, sorediis granulosis, partim submarginalibus, lobis sorediatis plus minusve revolutis, superne planus vel rugulosus, minute rimosus in aetate, strato corticeo superiore 13–16 μ crasso, strato gonidiali 20–25 μ crasso, medulla alba, 80–90 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C−, KC−, P−, atranorinum, acidum protolichestericum et acidum usnicum continens.

Type in the Museum of the Royal Norwegian Society (TRH), collected near Barretts Berlin Mine, Barberton, Transvaal, Africa, Aug. 8, 1929, by O. A. Höeg (isotypes in LD, US).

Although *P. ochroglauca* is known from only one collection, it appears to be amply distinct because of a unique combination of characters. At first glance it seems to be *P. xanthina* (Müll. Arg.) Vain., an isidiate species with identical chemistry. However, *P. ochroglauca* is distinctly though not conspicuously sorediate, the soredia originating for the most part submarginally and eventually causing the lobe margins to become more or less revolute. The revolution is similar to but not so pronounced as that in *P. perlata* (Huds.) Ach. The soredia here are rather sparse and granular. This species is probably endemic to South Africa.

36. Parmelia viridiflava Hale, sp. nov.

Thallus laxe adnatus, membranaceus, mollescens, usque ad 10 cm. diametro, viridiflavicans, lobis rotundatis, parum lobatis, 9–12 mm. latis, integris vel centrum versus dentato-incisis, margine sorediatis, soraliis irregulariter sinuato-elongatis, centrum versus praecipue in axillis ciliatis, ciliis 1.0–1.5 mm. longis, superne laevigatus, nitidulus, aetate rimosus, ad apicem levissime albo-reticulatus, strato corticeo superiore 13–15 μ crasso, strato gonidiali 18–20 μ crasso, medulla alba, 85–90 μ crassa, strato corticeo inferiore 16–18 μ, inferne niger, modice

rhizinosus, ambitu castaneus atque late nudus, nonnunquam albo-variegatus. Apothecia pycnidiaque ignota. Thallus K−; medulla K−, C−, KC+ fugiter rosea vel fulvescens, P+ aurantiaca, acidum usnicum, acidum protocetraricum et acidum fumarprotocetraricum, rarius atranorinum continens.

Type in the U.S. National Herbarium, collected in mature pine forest, elev. 1220 m., at Lagos de Monte Bello, 50 km. southeast of Comitán, Chiapas, Mexico, Mar. 25, 1960, by M. E. Hale (no. 20415; isotypes in DUKE, REN, S, TNS).

This species reminds one at once of *P. miranda* Hale or *P. dominicana* Vain. The former species differs in having salacinic acid and more conspicuous soralia, the latter in lacking cilia. *Parmelia viridiflava* and *P. conformata* Vain, are the only *Amphigymnia* species with fumarprotocetraric acid. The cilia are often sparse and irregular but definitely occur at the tips as well as in the axils of the lobes. It seems to be an endemic Caribbean species related to *P. conformata.*

Additional specimens examined:

HAITI: Montagne Noire, near Kenscoff, elev. 5500 ft., *Wetmore* 2761 (MSC); west of Forêt des Pins, *Wetmore* 2923, 3219 (MSC), *Imshaug* 22846, 22869 (MSC); summit of Tête Etang, between Kenscoff and Furcy, *Imshaug* 22559 (MSC). DOMINICAN REPUBLIC: Gap on main ridge between Pico del Yaque and L. Chinguela, elev. 7000 ft., *Wetmore* 3701, 3706 (MSC).

37. Parmelia xanthina (Müll. Arg.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:37. 1890.

Parmelia chrysantha Tuck. Syn. N. A. Lich. 55. 1882. Type collection: Blue Ridge, Virginia, *Tuckerman* (FH–Tuck, holotype). Invalid name in syn.

P. proboscidea Tayl. var. *xanthina* Müll. Arg. Flora 67:616. 1884.

P. perlata var. *xanthina* (Müll. Arg.) Stizenb. Bericht. St. Gall. Naturw. Gesell. 1888–1889:156. 1889.

P. xanthina f. *isidiosa* Müll. Arg. Hedwigia 30:229. 1891. Based on *P. proboscidea* var. *xanthina* Müll. Arg.

P. caperata var. *madagascariacea* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:181. 1899. Type collection: Ambositra, Madagascar, *Rodriguez,* 1889. (P, holotype).

P. madagascariacea (Hue) des Abbayes, Bull. Inst. Fr. Afr. Noire, ser. A, 20:22. 1958.

P. nyasensis Dodge, Ann. Mo. Bot. Gard. 46:126. 1959. Type collection: Mt. Nchisi, Nyasaland, Africa, *Brass* 16922 (NY, holotype).

Type collection: Central Madagascar, *Hildebrandt* (G, holotype).

Thallus loosely attached, 8–20 cm. in diameter, saxicolous or corticolous, yellowish green; lobes rotund 8–12 mm. wide, margins isidiate-dissected on older lobes, ciliate, cilia 1.0–2.5 mm. long; upper surface plane, dull, reticulately cracked with age, densely isidiate, especially near the margins of lobes, isidia simple to coralloid branched, 0.05–0.08 mm. thick, 1 mm. high or more, often apically ciliate;

lower side black and rhizinate at the center, shiny dark brown and dark brown in a broad zone along the margins. Apothecia and pycnidia lacking.

Reactions: Thallus K+ more intensely yellow; medulla K−, C−, KC+ red, P−, atranorine, protolichesteric acid, usnic acid, and a KC+ unknown substance recrystallizing as clustered needles in G.E.; or K−, C−, KC−, P−, atranorine, protolichesteric acid, and usnic acid present.

Des Abbayes (1958) has studied and attempted to typify the various yellow isidiate Amphigymnias. He considered *P. xanthina* to be C+ rose (gyrophoric acid). Two other morphologically identical strains were also recognized: *P. aberrans* (Vain.) des Abb. (C−) and *P. madagascariacea* (Hue) des Abb. (KC+ red). Although des Abbayes was not able to find a satisfactory type for *P. proboscidea* var. *xanthina*, I received from Geneva a well-developed specimen from Madagascar which is apparently Müller's holotype. It is C− and contains protolichesteric acid. Furthermore, the holotype of *P. xanthina* f. *aberrans* Vain. actually contains gyrophoric acid, contrary to Vainio's report of a C− reaction (see discussion of *P. aberrans*). Hence the name *P. aberrans* should be applied to the tropical America population that reacts C+ rose. Typical *P. xanthina* with protolichesteric acid alone and *P. madagascariacea* (including *P. chrysantha* and *P. nyasensis*) with a KC+ unknown have identical ranges in North America, Africa, and Asia (figs. 10, 11). By our definition, they should be considered as chemical strains of one species, *P. xanthina*. In North America, *P. xanthina* is common on rock outcrops and on oaks in open swamps in the southeastern United States.

Additional specimens examined:

Protolichesteric acid present:

U.S.: ALABAMA: Oak Mountain State Park, Shelby Co., *Hale* 7143 (US); GEORGIA: Near Trenton, Dade Co., *Hale* 7387 (US); Vogel State Park, Union Co., *Hale* 7355 (US); Cloudland Canyon, Walker Co., *Anderson* 12969 (DUKE, US). MEXICO: CHIAPAS: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20163 (US); Km. 956 on highway 190, west of Ocozocoautla, *Hale* 20594 (US). NICARAGUA: JINOTEGA: southwest of Jinotega, *Standley* 10137 (F). SOUTHERN RHODESIA: Zimbabwe Hill, *Höeg* s.n. (TRH). MADAGASCAR: Road between Ivato and Ambatofinandrahana, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 19 (M, REN, UPS, US).

Unknown KC+ substance and protolichesteric acid present:

U.S.: VIRGINIA: Natural Bridge, Rockbridge Co., *Hermann* 15087 (US); NORTH CAROLINA: 8 mi. south of Raeford, Hoke Co., *Culberson* 7600 (DUKE); Dardin, Martin Co., *Culberson* 6684 (DUKE); 1 mi. east of Wise Fork, Jones Co., *Culberson* 4926 (DUKE); SOUTH CAROLINA: 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16543 (US); King Mountain State Park, Cherokee Co., *Hale* 7707 (US); TENNESSEE: Cliff Springs, Overton Co., *Phillips* 307 (US); GEORGIA: Near Claxton, Evans Co., *Hale* 7451 (US); Neels Gap, Lumpkin Co., *Hale* 7538 (US);

10 mi. northeast of Midway, Bryan Co., *Hale* 16799 (US); Unicoi State Park, White Co., *Culberson* 7291 (DUKE); ALABAMA; Cheaha State Park, Clay Co., *McCullough* 571 (US); 4 mi. south of Alexander City, Tallapoosa Co., *McCullough* 1042 (US); FLORIDA: 5 mi. east of Greenville, Madison Co., *Hale* 17613 (US); near Pensacola, Escambia Co., *Hale* 7991 (US); Dog Lake Recreation Area, Leon Co., *Hale* 16713 (US). MEXICO: OAXACA: 53 km. northwest of Oaxaca, *Hale* 20799 (US); Km. 686 on highway 190, northwest of Tehuantepec, *Hale* 20646 (DUKE, REN, TNS, US); CHIAPAS: El Zapotal, Tuxtla Gutiérrez, *Hale* 19975 (US).

MADAGASCAR: Road from Antsirabe to Fianarantsoa, Km. 202, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 20 (M, REN, UPS, US).

INDIA: Coonoor, Nilgheries Mountains, *Gray* s.n. (P).

Additional localities cited by Hale (1959b) from Kentucky, Virginia, North Carolina, South Carolina, Tennessee, Georgia, Alabama, Florida, Arkansas, Costa Rica, and Madagascar are not repeated here.

Series *Emaculatae*, ser. nov.

Thallus cinereo-albicans, acido usnico destitutus, lobis ciliatis, superne emaculatus, subtus margine nigricans, castaneus, rarius albo-variegatus vel albicans.

Type species: *Parmelia crinita* Ach.

This large series of 41 species includes 10 cosmopolitan species, 12 endemic to Africa, and 10 endemic to the Americas. It includes some of the more familiar temperate species such as *P. arnoldii*, *P. crinita*, *P. perlata*, and *P. stuppea*. Chemical and morphological diversity is very great, but no further subdivision of the series seems possible at this time.

38. Parmelia abnuens Nyl. Flora 68:610. 1885. PLATE 7

Parmelia callitricha Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:178. 1909. Type collection: Between São Amaro and Barra Mansa, and near Palmeiras de São Lourenzo, São Paulo, Brazil [one collection] *Schiffner*, June 1901 (W, holotype).

Type collection: Brazil, *Glaziou* 1835 (H, Nyl, herb. no. 35290, lectotype).

Thallus loosely attached on bark, 4–8 cm. across, mineral gray; lobes rotund, 8–15 mm. wide, becoming quite laciniate, laciniae 1×2–4 mm., often appearing canaliculate below, margins densely ciliate, cilia 3–5 mm. long; upper surface shiny, distinctly to faintly maculate, pitted-rugose with age; lower side black and sparsely rhizinate at the center, dark brown to mottled tan and naked at the margins. Apothecia common, stalked, 5–10 mm. in diameter, amphithecium rugose, strongly maculate, disc imperforate; hymenium 90–110 μ high; spores 12–18×24–35 μ, episporium 2.5–3.0 μ thick; pycnidia present, conidia 6–8 μ long (after Nylander).

Reactions: Thallus K+ yellow; medulla K—, C+ deep orange red, KC+ deep orange red, P—, atranorine and olivetoric acid present (proved with chromatography).

Parmelia abnuens is superficially near *P. melanothrix* (Mont.) Vain. and related nonsorediate, nonisidiate species. It is separated by the deep C+ red reaction. The only close relative is *P. amboimensis* Dodge, an African species with small spores and an even more laciniate thallus. The differences in spore size between the types of *P. abnuens* (20–24 μ) and *P. callitricha* Zahlbr. (30–36 μ) are much larger than we expect to find in Parmelias, but there seems to be no justification for recognizing two species on spore size alone.

The second syntype on which Nylander based the name *P. abnuens* is a Lorentz collection from Uruguay. This specimen in Nylander's herbarium is *P. argentina* Krempl h.

39. Parmelia amboimensis Dodge, Ann. Mo. Bot. Gard. 46:158. 1959.

PLATE 7

Type collection: Amboim, Capir, Cuanza Sul, Angola, *Gossweiler* 9993 (K, holotype; US, isotype).

Thallus large, loosely attached, more or less suberect, 10–15 cm. across, mineral gray; lobes 10–12 mm. wide, irregularly branched and richly laciniate, laciniae 1–2×10 mm., appearing canaliculate below, margins sparsely ciliate, cilia 1–2 mm. long; upper surface smooth, dull to shiny; lower side black and sparsely rhizinate, dark brown to mottled tan and naked at the margins. Apothecia stalked, 8–15 mm. in diameter, amphithecium rugose, faintly maculate, disc imperforate hymenium 70–75 μ high; spores 7–8×10–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ deep orange red, KC+ deep orange red, P−, atranorine and olivetoric acid present (proved with chromatography).

This species has a decidedly everniiform appearance with broadly caniculate secondary lobes. The main lobes, however, are wide and the apothecia are stalked and rugose, unlike any species in *Pseudevernia* Zopf. The closest relative is the Brazilian species *P. abnuens* Nyl., which differs in having less laciniate lobes and larger spores.

Additional specimens examined:

ANGOLA: CUANZA SUL: Carloaongo-Cuvo, Capir, Amboim, *Gossweiler* 10008, 10038 (US).

40. Parmelia appendiculata Fée, Ess. Crypt., Suppl. 118, *pl. 38, fig. 3.* 1837.

Parmelia cristata Nyl. Flora 52:291. 1869. Type collection: Caripe, Venezuela, *Moritz* (H, holotype, Nyl. herb. no. 35293).

P. merrillii Lynge, Ark. Bot. 13, no. 13:79. 1914. Type collection: Coxipó, Igreja, near Cuyabá, Mato Grosso, Brazil, *Malme* 2198B (S, holotype). Not *P. merrillii* Vain. (1909).

P. cornuta var. *crocea* Lynge, Ark. Bot. 13, no. 13:78. 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2477 bis (S, holotype; W, isotype). (Unidentified anthraquinone pigment present in addition to K− yellow pigments.)

P. lyngeana Zahlbr. Cat. Lich. Univ. 6:243. 1929. Based on *P. merrillii* Lynge.

P. crocea (Lynge) Gyel. Repert Sp. Nov. Fedde 29:287. 1931. [Non *P. crocea* (Ach.) Spreng. =*Solorina*.]

Type collection: Bourbon, s.c. (G, isotype).

Thallus loosely adnate to bark, 3–6 cm. in diameter, buff mineral gray in herbarium, lobes rotund, 5–8 mm. wide, laciniate, laciniae 1 mm. wide, 3–8 mm. long, margins of lobes sparsely ciliate, cilia 1 mm. long; upper surface dull, reticulately cracked with age, soredia and isidia lacking; medulla white or in part pale to deep yellow-orange; lower side black and sparsely rhizinate, dark brown, naked and rugulose in a broad zone along the margins. Apothecia short-stalked, exciple dentate to dentate-laciniate, sparsely ciliate, amphithecium maculate, disc imperforate; hymenium 100–130 μ high; spores 14–16×26–32 μ, the episporium 2.5–3.0 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K− or K+ yellowish, C+ yellowish, KC+ yellowish, P−, atranorine, an unidentified pigment, and unknown substances present.

Although *P. appendiculata* was described some 125 years ago, the name has only rarely appeared in the literature. The type was carefully illustrated by Fée but the most critical character, the chemistry, was not known. Fortunately an isotype found at Geneva has enabled us to characterize the species accurately for the first time. The medulla is white to pale yellow and distinctly yellow under the apothecia, with a K− pigment identical with that in *P. araucariarum* Zahlbr. and others. The marginal laciniae are well developed but cilia are sparse and short. This species is extremely rare and known only from the type collections cited above.

Des Abbayes (1956) compared *P. appendiculata* and *disparilis* Nyl. on the basis of Fée's illustration and on his own collections from Madagascar. These two species are indeed similar externally, but *P. disparilis* contains protocetraric acid, lacks any pigment, and has smaller spores.

41. Parmelia arnoldii Du Rietz, Nyt Mag. Naturv. 62:80. 1924.

Type collection: Munich, Germany, *Arnold Exs.* 136b (UPS, lectotype; DUKE, FH, H, LD, isotypes).

Thallus loosely attached to bark, 8–20 cm. in diameter, light mineral gray; lobes 8–15 mm. wide, with dentate marginal laciniae, 2–4 mm. wide, 5–10 mm. long, crowded toward the center; upper surface shiny, faintly maculate, sorediate, soredia developing mostly on the laciniae, submarginal, eventually coalescing into extensive soralia, tips of sorediate lobes usually revolute, margins ciliate, cilia rather sparse, 1.0–2.5 mm. long; lower side black and rhizinate at the center,

brown and naked in a broad zone at the margin. Apothecia very rare, hymenium 80 μ high; spores 9.5–12×15–22 μ; conidia 10.5–11.5 μ long (after Hillmann, 1934).

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ reddish orange, P—, atranorine and alectoronic acid present; rhodophyscin also present in the lower medulla in some specimens, reacting K+ purple.

Parmelia arnoldii is a temperate species of both Northern and Southern Hemispheres (fig. 16) (cf. Degelius, 1935). It is distinguished by the sublaminal soredia and the presence of alectoronic acid, often accompanied by rhodophyscin. *Parmelia margaritata* Hue, which differs only in having salacinic acid and lacking rhodophyscin, has a restricted distribution in North America (fig. 9).

The typification of *P. arnoldii* is somewhat involved. Du Rietz proposed it as a new name for "*P. nilgherrensis* Nyl." (1874) non *P. nilgherrensis* Nyl. (1869) and a number of other misidentified literature reports by Hue and Lynge. *Parmelia nilgherrensis* Nyl. (1874) is a specimen (*Arnold Lich. Exs.* 136b) from Germany which Nylander had misidentified. The original *P. nilgherrensis* (1869) is an Asian species. The most appropriate lectotype for *P. arnoldii* is *Arnold* 136b, a typically developed specimen widely distributed in the larger herbaria.

Additional specimens examined:

CANADA: BRITISH COLUMBIA: Cedar Hill, Vancouver Island, *Melburn* 90 (US); Spring Island, Vancouver Island, *Szczawinski* 418 (US). U.S.: MAINE: Mt. Katahdin, *Degelius* s.n. (US); WEST VIRGINIA: 5 mi. northeast of Thornwood, Pocahontas Co., *Hale* 12362 (US); Spruce Knob, Pendleton Co., *Hale* 15460 (US); MICHIGAN: Isle Royale, Keweenaw Co., *Wetmore* 5044 (LD); MINNESOTA: 2 mi. northwest of Illgen City, Lake Co., *Spross* s.n. (US); VIRGINIA: Hawksbill Mountain, Madison Co., *Hale* 18937 (US); Whitetop Mountain, Washington Co., *Hale* 18739 (US); TENNESSEE: Roan Mountain, Carter Co., *Phillips* 374 (US); KENTUCKY: Rockcastle River at Route 192, Pulaski Co., *Reed* 56753 (Reed Herbarium); WASHINGTON: Hoh River, Jefferson Co., *Brown* 160 (US); Longbeach, Pacific Co., *Howard* 4851 (WIS); OREGON: Road between Bridal Veil Falls and Larch Mountain, Multnomah Co., *Hale* 21587 (US); CALIFORNIA: Pilarcitos Creek Canyon, San Mateo Co., *Thomson* 4761 (WIS), *Cain* 26388 (TRT, US), *Herre* 825 (MO); Near Saratoga, Santa Clara Co., *Cain* 26394a (TRT, US); Mt. Tamalpais, Marin Co., *Morton & Howell* 11905 (US). MEXICO: MEXICO: Popocatepetl, *Cain* 27595 (TRT, US); 10 km. southwest of Cahuacán, *Madrigal* 1426 (US); PUEBLA: Near Llano Grande, *Hale* 19302 (DUKE, MSC, REN, S, TNS, US); OAXACA: Cerro San Felipe, *Hale* 20708 (US). GUATEMALA: CHIMALTENANGO: Region of Santa Elena, *Standley* 58718 (MO).

HAITI: Near summit of Morne Macaya, *Wetmore* 3352 (MSC), 3358 (MSC, US); summit of Tête Étang, *Imshaug* 22614 (MSC, US). DOMINICAN REPUBLIC: Summit of Alto de la Bandera, *Wetmore* 3483 (MSC, US); southwest slope of La Rucilla, Maciso de los Yaques, *Imshaug* 23614 (MSC, US); La Nevera, Cordillera Central, *Wetmore* 3450 (MSC, US), *Imshaug* 23342 (MSC, US). GUADELOUPE: *Palmer* s.n. (FH).

CHILE: Valparaiso: Alto del Puerto, Valparaiso, *Santesson* 2761, 2798, 2878 (S); Concepción: Coronel, *Santesson* 2379 (S); Valdivia: Malihue, Río San Perdo, *Santesson* 3348 (S); Corral, *Santesson* 2329 (S); Enco, Lago Riñihue, *Santesson* 7595 (S); Aysén: Puerto Aysén, *Santesson* 6934 (S).

FRANCE: Lorges, *des Abbayes, Lich. Armor. Spect. Exs.* 32 (LD). GERMANY: Munich, *Arnold, Lich. Monac.* 492 (MICH); Bleckenau, Schwaben, *Förster, Lich. Alp.* 194 (LD, M, US). POLAND: Puszcza Bukowa, Bieszczady Zachodnie, *Glanc* in *Lich. Polonica* 173 (UPS). NORWAY: Rogaland, *Havaas, Lich. Norv. Occ. Exs.* 84 (LD).

42. Parmelia bangii Vain. Bot. Tidsskr. 29:104. 1909.

Type collection: La Paz, Bolivia, *Bang* 13 (H, holotype, Nyl. herb. no. 35500).

Thallus loosely attached to bark, 8–15 cm. in diameter, turning buff in the herbarium; lobes rotund, irregular, 5–8 mm. wide, margins entire, very sparsely ciliate, cilia 1.0–1.5 mm. long, mostly along the lateral edges; upper surface dull, continuous or reticulately cracked with age, cortex distintegrating in large areas near the margins and developing into sorediate pustules; lower side black and moderately rhizinate, light brown, shiny, and naked along the margins. Apothecia adnate, amphithecium pustulate, disc imperforate; hymenium 70–80 μ high; spores 11–16$\times$26–36 μ, episporium 3–4 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange red, atranorine and stictic acid present.

This is a rare species apparently endemic to tropical South America. The spore size and chemistry place it close to *P. perlata* (Huds.) Ach., but the development of extensive laminal sorediate pustules is unique.

Additional specimen examined:

COLOMBIA: Chapinero, *Ariste-Joseph* A355a (US).

43. Parmelia blanchetii Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:199. 1899.

Type collection: Bahia, Brazil, *Blanchet* (P, holotype; BM, isotype).

Thallus loosely adnate on rock, 8–10 cm. in diameter, light mineral gray; lobes rotund to irregular, 5–8 mm. wide, margins crenate to dentate-lobulate, especially toward the center, more or less black-rimmed, ciliate, cilia 1.5–2.5 mm. long; upper surface plane, shiny, reticulately cracked with age, isidia and soredia lacking; lower side black and sparsely rhizinate, dark brown and naked in a broad zone along the margins. Apothecia stalked, 4–6 mm. in diameter, amphithecium slightly rugose, disc imperforate; hymenium 50–60 μ high; spores 5–6$\times$12–15 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, KC+ reddish orange, fading rapidly, P+ orange red, atranorine and protocetraric acid present.

This unique species is known from only two collections. It is apparently saxicolous. Externally it is rather close to *P. eciliata* (Nyl.) Nyl., a corticolous species which has stictic acid and large spores.

Additional specimen examined:

COLOMBIA: Vaupes: Mesa de Yambí, Río Karurú, *Schultes* 19125 (FH, US).

44. Parmelia breviciliata Hale, sp. nov.

Parmelia latissima f. *microspora* Lynge, Ark. Bot. 13, no. 13:45. 1914.

Type collection: Near Bocca da Serra, Serra da Chapada, Mato Grosso, Brazil, *Malme* 2244* (S, lectotype).

Thallus laxe adnatus, saxicola, rigidulus, cinereo-albicans, 5–15 cm. latus, lobis rotundatis, 8–12 mm. latis, margine integris vel aetate irregulariter lobulatis, modice ciliatis, ciliis brevibus, 1–2 mm. longis, superne planus, opacus, continuus vel aetate plus minusve rimosus, medulla alba, subtus niger, sparse rhizinosus, ambitu castaneus, nudus. Apothecia 4–10 mm. diametro, primo urceolata, substipitata, disco imperforato, amphithecio opaco, excipulo integro; hymenium 45–55 μ altum; sporae 6–10×12–17 μ, episporio 1.0–1.5 μ lato. Thallus K+ flavescens; medulla K—, C—, KC+ rosea, P—, atranorinum et acidum alectoronicum continens.

Type in Lund University, collected 4 miles southeast of Pilgrims Rest, Transvaal, Union of South Africa, Oct. 10, 1953, by Ove Almborn (no. 7800; isotype in US).

Parmelia breviciliata is most common on rocks in South Africa, although there are disjunct localities in South America and Thailand (fig. 23). It resembles most closely *P. wainii* A. L. Sm., which differs chiefly in having intermediate spores, strongly stalked maculate apothecia, a ciliate exciple, and corticolous habit. *Parmelia soyauxii* Müll. Arg., another saxicolous African lichen, is superficially very similar but lacks cilia and contains lecanoric acid. A second Malme collection (2244) from Mato Grosso was tentively identified by Lynge as *P. proboscidea* f. *incrassata* Lynge; this specimen (S) is *P. breviciliata*.

Additional specimens examined:

BRAZIL: Mato Grosso: Near Bocca de Serra, Serra da Chapada, *Malme* s.n., 2244 (S).

IVORY COAST: Mont Tonkoui, cercle of Man, *Santesson* 10634 (UPS). CAMEROONS: Bafut-Ngem Forest Reserve, *Brunt* 773 (K, US). UGANDA: Entebbe, *Proctor* s.n. (K). ANGOLA: Huila: North of Sá-da-Bandeira, *Degelius* s.n. (DEGEL, US). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH, US). UNION OF SOUTH AFRICA: Transvaal: 6 mi. north of Houtbosch, *Almborn* 6720 (US); Barberton, *Höeg* s.n. (TRH); Fairy Glen, Pretoria, *Bottomly* 719 (PRE); Natal: Table Mountain, Pietermaritzburg, *Almborn* 8591, 8592 (LD). MADAGASCAR: Ambositra, *Forsyth* 629 (BM); road from Tananarive to Ankazobe, Km. 48, *des Abbayes, Lich. Madagasc. Borb. Sel. Exs.* 15 (M, REN, UPS, US). THAILAND: Kao Krading, *Kerr* L23 (K).

45. Parmelia corniculans Nyl. Flora 68:607. 1885.

Type collection: Java, *Horsfield* (H, lectotype, Nyl. herb. no. 35308).

Thallus loosely attached, 7–12 cm. broad, light mineral gray; lobes rotund, 10–13 mm. wide, margins smooth to more or less crenate, more or less dentate-laciniate with age, ciliate, cilia to 2 mm. long; upper surface dull, plane, soredia and isidia lacking; lower side black and sparsely rhizinate, dark brown to brown and naked in a broad zone along the margins. Apothecia 4–8 mm. in diameter, stalked, exciple more or less dentate, short-ciliate, amphithecium rugulose, maculate, disc perforate; hymenium 80–85 μ; spores 16–18×30–35 μ, episporium 3 μ thick; pycnidia numerous, conidia 5–6 μ long.

Reactions: Thallus K+ yellow; medulla K—, KC+ reddish orange, C—, P—, atranorine and alectoronic acid (mixed with α-collatolic acid) present; rhodophyscin often present in the lower medulla, K+ purple.

This species seems to be restricted to Malaysia and is therefore quite separated geographically from comparable species with alectornic acid in Africa and America. The only really closely related species is *P. maclayana* Müll. Arg., which lacks such conspicuous laciniae and has small spores. *Parmelia merrillii* Vain., an Asian species, has similar laciniae and large spores, but differs in containing protocetraric acid and having imperforate apothecia.

Additional specimens examined:

PHILIPPINES: Luzon: Mt. Tonglon, *Ramos* 5493 (US); Baguio, Benguet, *Elmer* 8563 (US). JAVA: Mt. Gedeh, *Groenhart* 8812 (BO). LAOS: Hase Plantation, *Tsuyama* 13 (TNS).

46. Parmelia cornuta Lynge, Ark. Bot. 13, no. 13:76, *pl. 2, fig. 5*. 1914.

Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *G. A. Malme* 2477 (S, holotype).

Thallus loosely attached, 10–15 cm. across, buff mineral gray in herbarium; lobes rotund, 7–10 mm. wide, margins entire, becoming dentate-laciniate towards the center, ciliate, cilia sparse, 2–3 mm. long; upper surface dull, more or less rugulose, cracked with age, isidia and soredia lacking; medulla lemon yellow; lower side black, sparsely rhizinate in the center, brown to tan and naked in a broad zone at the margins. Apothecia substipitate, exciple dentate and ciliate, amphithecium maculate, disc imperforate; hymenium 110–130 μ high; spores 13–15×26–32 μ, episporium 3 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla lemon yellow, K—, C—, KC—, P—, atranorine and vulpinic acid present.

Parmelia cornuta is superficially very near to *P. appendiculata* Fée except for the presence of vulpinic acid. Both species have

dentate-laciniate apothecia, sparse cilia, and large spores. *Parmelia sulphurata* Nees & Flot., an isidiate species, is the only other *Parmelia* with vulpinic acid. *Parmelia cornuta* is still known only from the Mato Grosso region.

Additional specimen examined:

BRAZIL: Mato Grosso: Buriti, *Malme* s.n., 2243B (S).

47. Parmelia crinita Ach. Syn. Lich. 196. 1814. Plate 1

Parmelia proboscidea Tayl. *in* Mack. Fl. Hibern. 143. 1836. Type collection: Near Dunkerron, Ireland (FH–Tayl, holotype; isotype in BM).

P. perlata var. *ciliata* f. *dissectula* Nyl. *in* Leight. Lich. Fl. Gr. Brit. 120. 1879. Type collection: Killery Bay, Connemara, Ireland, *Larbalestier* s.n. (BM, holotype).

P. chlorocarpa Müll. Arg. Flora 63:265. 1880. Type collection: Caracas, Venezuela, *Ernst* in 1879 (G, holotype).

P. schweinfurthii Müll. Arg. Proc. Roy. Soc. Edinburgh 2:459. 1882. Type collection: Socotra, Africa, *Schweinfurth* (G, holotype).

P. proboscidea var. *dissectula* (Nyl.) Müll. Arg. Flora 67:616. 1884.

P. catharinensis Müll. Arg. f. *isidiosa* Müll. Arg. Flora 74:378. 1891. Type collection: Southern Brazil, *Leyland* (K, holotype; G, isotype).

P. perlata var. *dissectula* (Nyl.) Müll. Arg. Bull. Soc. Bot. Belg. 32:127. 1893.

P. pilosella Hue, Journ. de Bot. 12:247. 1898. Type collection: Coatloch Forest, Finistère, France, *Picquenard* in 1898 (P, lectotype; BM, isotype).

P. pilosella f. *excrescens* Hue, Journ. de Bot. 12:249. 1898. Type collection: Munich, Germany, *Arnold Lich. Exs.* 655a (P, lectotype; BM, isotype).

P. crinita f. *pilosella* (Hue) Merrill, Bryol. 11:95. 1908. Based on *P. pilosella* Hue.

(?)*P. tuckermanii* Du Rietz, Nyt Mag. Naturvid. 62:70. 1924. Type collection: *Wright, Lich. Cubae* 69 (UPS, holotype; FH, M, US, YU, isotypes).

P. pseudocatharinensis Gyel. Repert. Sp. Nov. Fedde 29:289. 1931. Based on *P. catharinensis* Müll. Arg. f. *isidiosa* Müll. Arg.

Type collection: North America, *Muhlenberg* (H, holotype).

Thallus adnate to loosely attached, 8–25 cm. in diameter, mineral gray; lobes rotund to irregularly dissected, 6–12 mm. wide, margins crenate, often isidiate and dissected on older lobes, ciliate, cilia 1–2 mm. long; upper surface dull, plane, moderately to densely isidiate, isidia simple to coralloid-branched, 0.05–0.1 mm. thick, to 2 mm. high, often apically ciliate; lower side black and sparsely rhizinate, dark brown to tan, more or less rugose, shiny, and naked in a broad to rather narrow zone at the margins. Apothecia rare, 3–8 mm. in diameter, substipitate, amphithecium isidiate, disc imperforate; hymenium 65–80 μ high; spores 12–16$\times$25–30 μ, episporium 3–4 μ thick; pycnidia rare, conidia 3–4 μ long (after Asahina).

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange yellow, atranorine and stictic acid present.

Parmelia crinita is a very common cosmopolitan species known to all lichenologists. It has a remarkable range of climatic adaptability,

from purely tropical areas to temperate and even subboreal forests (fig. 17) (cf. Degelius, 1935). The isidia vary widely from simple and sparse to densely coralloid-branched and ciliate. The lobes are rather small and have a relatively narrow, shiny, often rugose bare zone below. It is the only isidiate species in the subgenus with stictic acid. *Parmelia subcrinita* Nyl., which contains salacinic acid, is in general a more robust plant with a broad bare zone below. *Parmelia mellissii* Dodge in a few cases has coralloid isidia that could be confused with those of *P. crinita* but it is K— (alectoronic acid) and has smaller spores.

Parmelia internexa Nyl., which is classified in the subgenus *Parmelia*, differs chiefly in size. It has adnate lobes at most 4 mm. wide and a narrow papillate zone below.

Parmelia tuckermanii Du Rietz was described from a Wright Cuban collection that contains spores significantly smaller (about 18 μ long) than in any specimens of *P. crinita* that I have examined. Since spore size is the only difference between it and *P. crinita*, sterile specimens must be referred to *P. crinita*. I believe the smaller spores are juvenile or otherwise abnormal.

Additional representative specimens examined:

CANADA: Nova Scotia: Hunt's Point, *Denison* (US). Ontario: Hibbard Bay, Algoma Distr., *Cain* 26882, 26884 (TRT, US); Brighton, *Macoun* 67, 175 (US). U.S.: Maine: Mt. Desert Island, Hancock Co., *Davis* 68 (US); Rockland, Knox Co., *Merrill, Lich. Exs.* 124 (FLAS, US); Connecticut: Aton Forest, Litchfield Co., *Hale* 71 (US, YU); New York: Jamesville, Onondaga Co., *Cook* s.n. (US); Maryland: 6 mi. west of Town Hill, Alleghany Co., *Hale* 14503 (US). West Virginia: 4 mi. east of Baker, Hardy Co., *Hale* 15024 (US); Bluestone Dam, Summers Co., *Hale* 11707 (US); Jaeger, McDowell Co., *Hale* 10832 (US); Ohio: Junction of routes 374 and 56, Hocking Co., *Hale* 13299 (US); Kentucky: Near Forest Cottage, Cumberland Co., *Hale* 13714 (US); Wisconsin: Upper Brule River, Douglas Co., *Thomson* s.n. (WIS); Michigan: Lower Tahquamenon Falls, Chippewa Co., *Imshaug* 19906 (MSC, US); Iron Bridge, Cheboygan Co., *Robinson* s.n. (US); Minnesota: Grand Portage Island, Cook Co., *Fink* 114 (US); Duluth, St. Louis Co., *Kimball* s.n. (US); Iowa: Fayette Co., *Fink* s.n. (US); Missouri: Near Ava, Douglas Co., *Hale* 4327 (US); Laquey, Pulaski Co., *Hale* 4079 (US). Virginia: Mountain Lake Biological Station, Giles Co., *Hale* 18414 (US); 2 mi. east of Buena Vista, Rockbridge Co., *Hale* 18345 (US); Browntown Valley Overlook, Skyline Drive, Rappahannock Co., *Hale* 14732 (US); Doughat State Park, Bath Co., *Hale* 12401 (US); North Carolina: 2 mi. south of West Jefferson, Ashe Co., *Culberson* 6306 (DUKE); Cleveland, Rowan Co., *Culberson* 6132 (DUKE); Gastonia, Gastonia Co., *Hale* 8144 (US); Forney Ridge, Great Smoky Mountains, *Degelius* s.n. (US); South Carolina: Near Greenville, Greenville Co., *Hale* 7762 (US); 5 mi. east of Walterboro, Colleton Co., *Hale* 16502 (US); Tennessee: 2 mi. north of Carters Gap, Carter Co., *Hale* 18003 (US); Cliff Springs, Overton Co., *Phillips* 301 (US); Georgia: Chatsworth, Murry Co., *Hale* 7416 (US); Neels Gap, Lumpkin Co., *Hale* 7559 (US); Alabama: Oak Mountain State Park, Shelby Co., *Hale* 7156 (US); 4 mi. southeast of Troy, Pocosin area, *McCullough* 472, 476 (US); Florida: 8 mi. east of Ocala, Marion

Co., *Hale* 17033 (US); Oleno State Park, Alachua Co., *Hale* 16739 (US); Highlands Hammock State Park, Highlands Co., *Hale* 16937 (US); ARKANSAS: Nogo, Pope Co., *Hale* 2975 (US); Dardanelle, Yell Co., *Hale, Lich. Amer. Exs.* 16 (BM, C, CAN, FH, FU, ID, ILL, L, LD, LISU, M, MO, NY, S, TENN, TRT, UC, US, W, WIS); OKLAHOMA: South of Albion, Pushmataha Co., *Hale* 4976 (US); TEXAS: Near Woodville, Tyler Co., *Hale* 5218 (US); Jasper, Jasper Co., *Hale* 5411 (US); ARIZONA: Santa Rita Mountains, Santa Cruz Co., *Darrow* 4394 (Darrow Herbarium); MEXICO: VERACRUZ: 33 km. northeast of Perote, *Hale* 20871 (US), 20892 (COLO, US); OAXACA: Cerro San Felipe, *Hale* 20787 (LISU, US); CHIAPAS: 50 km. west of Tuxtla Gutiérrez on highway 190, *Hale* 19907 (DUKE, S, TNS, US); 14 km. west of San Cristóbal, *Hale* 20566 (US). GUATEMALA: QUETZALTENANGO: Between Zunil and Cantel, *Standley* 83905 (MO). HONDURAS: El Paraiso, Güinope, *Valerio* 1816 (MO). NICARAGUA: JINOTEGA: West of Jinotega, *Standley* 9766 (F); MASAYA: Region of Las Nubes, *Standley* 8749 (F). COSTA RICA: GUANACASTE: Aguilares, *Standley* 46355 (US); CARTAGO: Along the Río Reventado, *Standley* 49601 (US); 1 mi. south of Cartago, *Danilson* 17 (MICH); ALAJUELA: San Pedro de San Ramón, *Brenes* 457 (UPS).

CUBA: LAS VILLAS: Trinidad Mountains, *Imshaug* 24599 (MSC); ORIENTE: El Gato, Loma del Gato, Sierra Maestra, *Imshaug* 24819 (MSC, US), 24926 (MSC, US), 24768 (MSC), *Hioram* 8467 (FH), *Leon* 10613 (NY); Loma San Juan, Guantánamo, *Hioram* 10268 p.p. (FH); summit of Pico Turquino, *Imshaug* 25105 (MSC). HAITI: Near summit of Morne Macaya, *Imshaug* 23252 (MSC, US); summit of Tête Étang, *Imshaug* 22587 (MSC). DOMINICAN REPUBLIC: Along road at Los Amaceyes, *Wetmore* 3399 (MSC); near Cerrazos, on ridge from La Cumbre to Santiago, *Wetmore* 3856 (MSC, US), 3862 (MSC); summit of Pico de Isabel de Torres, near Puerto Plata, *Imshaug* 23939 (MSC, US). JAMAICA: Coopers Hill in the Red Hills, *Imshaug* 13721, 13729, 13744, 14125, 14141 (MSC); Dolphin Head, Hanover, *Imshaug* 15647 (MSC); Blue Mountain Peak Trail, St. Thomas, *Imshaug* 12951 (MSC, US); Hollymount, Mt. Diablo, *Imshaug* 14190 (MSC, US), 14192, 14212 (MSC); Newcastle, *Cushman* 40 (FH); without locality, *Eggers* 3779 (C). PUERTO RICO: Mt. Torrecella, *Sintenis* 32 (G). VIRGIN ISLANDS: ST. THOMAS: Signal Hill, *Eggers* s.n. (S); Crown, *Britton* 1441 p.p. (NY).

VENEZUELA: MÉRIDA: Río Chama Valley, Mérida, *Dennis* 2335 (K). COLOMBIA: CUNDINAMARCA: Near Zipaquirá, *Schultes* 11441 (FH, US); TOLIMA: Between Cajamarca and summit of Divide, *Killip* 34678b (US). CHILE: CAUTIN: Llainia, *Gunckel* 19453 (MO); VALDIVIA: Lago Riñihue, *Santesson* 3510, 3732, 7146 (S); CHILOÉ: Petrohué, *Hosseus* 187 (M); Isla Chiloé, Peninsula Lacui, *Santesson* 4092 (S), 4116 (S, US); JUAN FERNANDEZ: *Reed* s.n. (BM), *Hassler* s.n. (K).

SCOTLAND: Dungallan Parks, Argyll, *Lindahl* 176 (UPS). ENGLAND: Sussex, *Borrer* s.n. (US). NORWAY: Skarås, Regefjord, Rogaland, *Hasselrot* (S). FRANCE: Forêt du Cranou, Finistère, *Almborn*, Aug. 20, 1954 (LD, US); St. Thurial, Ille-et-Vilaine, *Santesson* 10084a (UPS, US). HUNGARY: Near Rónafüred, *Szatala, Fl. Hung. Exs.* 416 (LD, US). ITALY: Mt. Mulatto, near Predazzo, *Arnold, Lich. Exs.* 1151 (US); Deserto di Santa Anna, Cogoleto, *Gresino* 11445 (F). SPAIN: 2 km. northwest of Irurita, Navarra, *Santesson* 13291j (UPS). PORTUGAL: Near Pena, Serra de Sintra, Estremadura, *Tavares, Lich. Lusit. Sel. Exs.* 117 (LD, US, WIS).

KENYA: Tinderet Forest Reserve, Kisumu-Londiani, Nyanza Prov., *Maas Geesteranus* 11162 (L). UNION OF SOUTH AFRICA: TRANSVAAL: 5 mi. east of Mokobulaan, Lydenberg, *Almborn* 7495 (LD); north of Louis Trichardt, Zoutpansberg, *Almborn* 6542 (LD); NATAL: Eschowe, *Höeg* s.n. (TRH); Polela

Forest, Polela, *Almborn* 9504 (LD); near Pietermaritzburg, Umgeni, *Höeg* s.n. (TRH); Cathedral Peak Area, Bergville, *Almborn* 8872 (LD); CAPE PROVINCE: Tzitzikama Mountains, *Maas Geesteranus* 6624 (L); Fern Kloof, Albany, *Almborn* 10729 (LD); Paarl Rock, Paarl, *Almborn* 5422 (LD); east slope of Table Mountain, Wynberg, *Almborn* 11311 (LD); Blauwkrantz, Humansdorp, *Höeg* s.n. (TRH).

CHINA: Fukien Prov., *Sowerby* s.n. (US). JAPAN: Ohito, Prov. Idu, *Kurokawa* 58025 (TNS, US).

JAVA: Mt. Gedeh, Tjibodas, *Groenhart* 8550, 8764 (BO). FIJI: Mba, Viti Levu, *Smith* 4912 (US). AUSTRALIA: Ravenshoe, Duma Creek, *Sherrin* s.n. (BM).

48. Parmelia cryptoxantha des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:115. 1961.

Type collection: 30 km. northeast of Ankazobe, Forêt d'Ambohitantely, Centre Moyen, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Thallus 8–15 cm. in diameter, membranous, loosely attached, light mineral gray; lobes rotund, 8–15 mm. wide, margins crenate to short lobulate-dentate, conspicuously ciliate, cilia dense, 3–5 mm. long; upper surface plane to rugulose-pitted, cortex fragile and easily breaking away, becoming coarsely sorediate-pustulate in a broad zone along the margins; medulla very pale yellow to white; lower side black and sparsely rhizinate, black to brown, shiny, and naked in a broad zone along the margin. Apothecia substipitate, to 5 mm. in diameter, exciple short lobulate, sparcely ciliate, amphithecium rugose, maculate, disc imperforate; hymenium 75–90 μ; spores 10–12×24–28 μ, episporium 1.5–2.0 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medula K+ yellow, C−, P+ pale orange yellow, protolichesteric acid, atranorine, unknown P+ acids, and a pale yellow pigment present.

The morphological characters of *P. cryptoxantha* are rather peculiar: Laminal sorediate pustules, similar to those of *P. rimulosa* Dodge but more sparsely developed, long cilia, and a membranous, fragile thallus. The chemical components are unknown except for atranorine and protolichesteric acid. The pigment is pale and easily overlooked.

Additional specimen examined:

NATAL: Forest south of Nkandhla, Nkandhla Distr., *Almborn* 8065 (LD, US).

49. Parmelia diacidula Hale, sp. nov. PLATE 13

Thallus expansus, membranaceus, laxe adnatus, 10–20 cm. diametro, viridi-glaucescens, lobis rotundatis, 10–15 mm. latis, margine integris vel late crenatis, centrum versus plus minusve breve dissectis, ciliatis, cillis sparsis, 0.5–2.5 mm. longis, sorediatis, soraliis linearibus, irregularibus, sorediis granulosis, superne planus, nitidus, levissime albomaculatus, cortice fragili, strato corticeo superiore

8–10 μ crasso, strato gonidiali 24–26 μ crasso, medulla alba, 75–90 μ crassa, strato corticeo inferiore 13–15 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia pycnidiaque ignota. Thallus K+ flavescens; medulla K−, C+ rosea, KC+ rubescens, P−, atranorinum, acidum gyrophoricum et acidum protolichestericum (et caperaticum?) continens.

Type in Lund University, collected in Boschfontein Forest, Lions River, Natal, Africa, Oct. 31, 1953, by Ove Almborn (no. 8679; isotype in US).

This species superficially resembles *P. dilatata* Vain, especially in the formation of soredia on irregularly dissected lobe margins. Cilia, however, are consistently produced even at the lobe tips and the thallus is more membranous. No other species of *Amphigymnia* produces gyrophoric and protolichesteric acids together, although this combination is known in the *P. cirrhata* group of the *Evernii-formes*. *Parmelia diacidula* is rather well collected and seems to be endemic to Natal.

Additional specimens examined:

UNION OF SOUTH AFRICA: NATAL: Indumeni Forest, Cathedral Peak Area, Bergville, *Almborn* 9189 (LD); Ingeli Forest, Alfred, *Almborn* 10250 (LD); Impetyne Forest, near Weza, *Almborn* 9961 (LD); forest south of Nkandhla, Nkandhla, *Almborn* 8068 (LD).

50. Parmelia direagens Hale, sp. nov.

Thallus laxe adnatus, 5–15 cm. diametro, cinereo-albicans, lobis rotundatis, 6–12 mm. latis, suberectis, margine integris, sinuatis vel breve laciniato-lobatis, sorediatis, soraliis linearibus, ciliatis, ciliis 1.5–2.5 mm. longis, superne nitidus, levissime albomaculatus, strato corticeo superiore 15–18 μ, strato gonidiali 15–20 μ, medulla alba, 80–100 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P−, soralia P+ citrina, atranorinum, acidum alectoronicum et acidum P+ ignotum continens.

Type in the British Museum, collected near Kimberly, Cape Province, South Africa, by John Shaw (isotype in US).

This remarkable species could easily be misidentified as *P. sancti-angelii* Lynge, but it differs significantly in chemistry. When P is applies to the medulla, no reaction is observed, but the soredia are P+ deep yellow. Alectoronic acid is produced throughout the medulla and the soredia, but the soredia also contain the P+ yellow unknown. There is no other *Parmelia* species with this reaction. The upper surface tends to be faintly white-maculate, whereas *P. sancti-angelii* is not clearly maculate.

Additional specimen examined:

UNION OF SOUTH AFRICA: TRANSVAAL: 5 mi. east of Mokobulaan, Lydenburg, *Almborn* 7499 (LD).

51. Parmelia eciliata (Nyl.) Nyl. *in* Fournier, Mex. Pl. 3. 1872.

Parmelia crinita var. *eciliata* Nyl. Flora 52:291. 1869.

P. resupina Stirton, Scot. Nat. 4: 298. 1877–78. Type of collection: Near Knysna, Cape Prov., Africa, *Knobel* (BM, holotype).

(?)*P. eurycarpa* Stein. & Zahlbr. Bot. Jahrb. Engler 60:530. 1926. Type collection: Amani, East Usambara, Africa, *Brunnthaler s.n.* (W, holotype).

Type collection: Orizaba, Mexico, *Bourgeau* (H, Nyl. herb. no. 35295, holotype; P, isotype).

Thallus loosely adnate, often found on twigs, membranous, up to 10 cm. wide, mineral gray; lobes rotund, soon more or less convoluted and crowded, margins crenate to lobulate-dissected, lobules to 3 mm. long, more or less canaliculate, ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, maculate near the base of apothecia, isidia and soredia lacking; lower side black and sparsely rhizinate, brown to tan or white variegated and naked in a broad zone along the margins. Apothecia common, stalked, up to 18 mm. in diameter, amphithecium rugose, strongly white-maculate, disc imperforate; hymenium 120–150 μ high; spores 12–18×23–30 μ, episporium 3 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow, C−, KC−, P+ pale orange yellow, atranorine and stictic acid present.

Parmelia eciliata has no close relatives among species with stictic acid. It is morphologically rather similar to *P. blanchetii* Hue and *P. abnuens* Nyl., both of which differ in chemistry and in various minor morphological characters. This species occurs mainly in the Caribbean area where it is common on branches of deciduous trees, but it is also rather common in southern South America and in South Africa (fig. 18). The type of *P. eurycarpa* is placed in synonymy tentatively because the holotype is in poor condition; the presence of stictic acid and lack of soredia make it highly probable that it is identical with *P. eciliata*.

Additional specimens examined:

MEXICO: HIDALGO: Chapulhuacan, *Lundell* 7214e (MICH); VERACRUZ: 36 km. southwest of Orizaba, *Hale* 19582 (S, US); 64 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19549 (US). NICARAGUA: JINOTEGA: Cerro de la Cruz, west of Jinotega, *Standley* 11091 (F).

CUBA: ORIENTE: Loma del Gato, *Hioram* 6693 (BPI); Gran Piedra, Sierra Maestra, *Imshaug* 25035 (MSC). HAITI: Summit of ridge on Tête Etang, elev. 5850 ft., *Wetmore* 2661 (MSC); summit of Montagne Noire, elev. 5500 ft., *Wetmore* 2798 (MSC); summit of ridge north of Forêt des Pins, elev. 5800 ft., *Imshaug* 22705 (MSC). JAMAICA: No locality, *Wolle*, 1875 (US).

BRAZIL: Rio de Janeiro: Serra dos Orgãos, *Burchell* 2251 (K). ARGENTINA: Near Salta, *Smith* 4676 (US); Delta of Río Paraná, Buenos Aires, *Sentesson* 109, 110, 1186 (S); no locality, *Lorentz & Hieronymus*, 1872–76 (M).

UNION OF SOUTH AFRICA: Transvaal: Kaaimansgat Forest, Woodbush, *Mogg* 1990 (PRE); Cape Prov.: Dassies Krantz, Grahamstown, *Almborn* 4017 (LD); 6 mi. N. of Knysna, Knysna, *Almborn* 2619 (LD, US).

52. Parmelia erasmia Hale, sp. nov.

Thallus laxe adnatus, saxicola, 5–10 cm. diametro, cinereo-glaucescens, lobis rotundatis, 8–10 mm. latis, margine ciliatis, ciliis 2.0–2.5 mm. longis, superne opacus, aetate rimosus, isidiatus, frequenter superficie neque margine, isidiis tenuibus ramosisque, strato corticeo superiore 20–25 μ crasso, strato gonidiali 18–20 μ crasso, medulla 60–70 μ alta, parte superiore alba, inferiore pro parte crocea, strato corticeo inferiore fusco, 15–20 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia et pycnidia ignota. Thallus K+ flavescens; medulla alba K−, C−, KC+ rosea, P−, medulla crocea K+ atropurpurea, atranorinum, acidum alectoronicum, et pigmentum croceum ignotum continens.

Type in the Chicago Natural History Museum, collected in the vicinity of El Zamorano, Morazán, Honduras, Nov. 26, 1946–Jan. 9, 1947, by P. C. Standley (no. 210; isotype in US).

Parmelia erasmia has the gross appearance of the widespread *P. crinita* Ach. The isidia are normal with no obvious tendency to become pustulate or sorediate. It might accidentally be placed with specimens of *P. mellissii* Dodge that have more normal isidia and well-developed pigments. However it is easy to prove with chromatography that the pigment in *P. mellissii* is rhodophyscin and that in *P. erasmia* is the same unknown anthraquinone found in *P. hypomiltoides* Vain. *Parmelia hypomiltoides* has coarsely sorediate margins. All three species must be carefully studied morphologically and chemically before identifications are made. In any event *P. erasmia* is a rare species apparently endemic to pine-oak forests in Mexico and Central America, where it is probably more common than the few records indicate.

Additional specimens examined:

MEXICO: Veracruz: Tecocelo Canyon, south of Xico, *Hale* 21139 (US). HONDURAS: Comayagua: Siguatepeque, *Standley & Chacón* 6257 (F. US); Morazan: Quebrada el Gallo, northeastern slopes of Cerro de Uyuca, *Morton* 7044 (REN, US).

53. Parmelia eurysaca Hue, Nouv. Arch. Mus. Paris, ser 4, 1:194. 1899. Plate 8

Type collection: Mexico, *Bourgeau* 1865–66 (P, holotype).

Thallus loosely adnate to bark, coriaceous, ashy white to mineral gray, 10–20 cm. broad; lobes rotund, 10–14 mm. wide, conspicuously dentate-laciniate toward the center, laciniae 1–2×5–10 mm., margins

ciliate, cilia 1–4 mm. long; upper surface plane, opaque to rather shiny, reticulately cracked with age, isidia and soredia lacking; lower side black and rhizinate in the center, brown to white-variegated in a broad zone at the margins. Apothecia 5–15 mm. in diameter, substipitate, amphithecium rugose, white-maculate, disc perforate; hymenium 35–45 μ high; spores 6–8×9–12 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia eurysaca is characterized by heavily pycnidiate marginal laciniae, which are always present in some degree. This is the only ciliate species with salacinic acid that lacks soredia or isidia. A very close sorediate relative is *P. stuppea* Tayl., which lacks distinct laciniae. *Parmelia eurysaca* is endemic to central and northern Mexico and the adjacent United States, occurring very commonly on oak trees on dry open hillsides along with *P. stuppea* and *P. praesignis* Nyl.

Additional specimens examined.

U.S.: Texas: Head of Camp Verde Creek, Bandero Co., *Parks* 1068 (US, WIS). Arizona: Cave Creek, Chiricahua Mountains, Cochise Co., *Weber et al.* 24741 (US). MEXICO: San Luis Potosí: Without locality, *Parry* 1022 (K); Alvarez, *Palmer* 465, 466 (US); Jalisco: San Sebastian, Sierra Madre Occidental, *Mexia* 1381, 1545c (F), 1904a (US); Hidalgo: Cuyamaloya, *Pringle* 10753 (US); El Hiloche, *Martinez* s.n. (US); Sierra de Pachuca, *Madrigal* 1415 (US); Veracruz: 64 km. southwest of junction of highways 140 and 155, northeast of Huatusco, *Hale* 19535 (US); 33 km. northeast of Perote, *Hale* 21220 (US); Mexico: North of Acambay, *Cain* 27597a (TRT, US); Sierra de las Cruces, *Pringle* 168 (COLO, US); Michoacán: 65 km. east of Morelia, *Hale* 20988 (US); Cerro Azul, Morelia, *Arsène* 3737 (US); 61 km. northwest of Zitácuaro, *Hale* 20861 (COLO, US); Oaxaca: Cerro San Felipe, *Hale* 20692 (DUKE, REN, S, TNS, US), 20709 (MSC, US).

54. Parmelia flavotincta Hale, sp. nov. Plate 6

Thallus expansus, laxe adnatus, membranaceus, 10–15 cm. latus, lobis rotundatis, 8–15 mm. latis, margine integris, centrum versus demum laciniatis, laciniis isidiiformibus, coralloideo-ramosis, apice granulato-fatiscentibus (ut in *P. fasciculata* Vain.), margine ciliatis ciliis 1–2 mm. longis, superne nitidus, planus, strato corticeo superiore 20–26 μ crasso, strato gonidiali 15–18 μ crasso, medulla alba, 90–125 μ crassa, strato corticeo inferiore 14–18 μ crasso, inferne niger, sparse rhizinosus, ambitu fusco-castaneus, late nudus. Apothecia atque pycnidia ignota. Thallus K+ flavescens; medulla K+ flavescens, C−, KC−, P+ flavotincta, atranorinum solum continens.

Type in Kew Herbarium, collected at Cross Line, 8 mi. east of Berbice, British Guiana, July 17, 1919, by A. A. Abrahamson (no. 229; isotype in US).

Parmelia flavotincta is the only *Amphigymnia* species that contains atranorine in the medulla. Morphologically it is close to *P. fasciculata* Vain. and *P. ramuscula* Hale in the formation of coralloid isidial structures but differs in having a more membranous thallus and distinct cilia.

Additional specimen examined:

COLOMBIA: VAUPÉS: Cachivera de Jirijirimo, *Schultes & Cabrera* 11986 (FH, US).

55. Parmelia fracta Hale, sp. nov.

Thallus expansus, laxe adnatus, 10–15 cm. latus, stramineo-flavicans, lobis rotundatis, usque ad 20 mm. latis, margine integris, centrum versus pro parte dentato-laciniatis, ciliatis, ciliis 1–2 mm. longis, pro maxima parte in lobis lateralibus, superne opacus, rugulosus, demum pustulato-sorediatus, cortice partim comminuente, strato corticeo superiore 15–18 μ crasso, strato gonidiali 14–16 μ crasso, medulla alba, 75–95 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus, late nudus. Apothecia magna, pedicellata, usque ad 15 mm. diametro, amphithecio valde rugoso, albomaculato, disco imperforato; hymenium 120–140 μ altum; sporae 16–20$\times$30–38 μ, episporio 3–4 μ crasso; pycnidia rara, conidiis non visis. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P+ aurantiaca, atranorinum, acidum usnicum, et acidum protocetraricum continens.

Type in the Farlow Herbarium, Harvard University, collected in Colombia, South America, by Lindig (no. 740; isotypes in H, M, US).

The upper cortex of *P. fracta* is quite fragile, flaking off and developing broad pustulate-sorediate areas, reminiscent of *P. bangii* Vain. and *P. rimulosa* Dodge. It is known only from the type collection. Nylander had given it the herbarium name of "*P. latissima* f. *flavida*."

56. Parmelia grayana Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:184. 1899.

Parmelia cinereoplumbea Harm. *in* Pitt. & Harm. Bull. Soc. Bot. Fr. 58, suppl. 22:32. 1911. Type collection: Riscos de Casitas, Canary Islands, *Pitard* 2001 (DUKE, holotype).

P. simodensis Asahina, Journ. Jap. Bot. 17:73, *fig. 79*. 1941. Type collection: Simoda, Prov. Izu, Hondo, Japan, *Asahina* (TNS, holotype).

Type collection: Coonoor, Nilgherries, India, *Gray*, 1893 (P, holotype).

Thallus saxicolous, adnate to loosely attached, 3–6 cm. in diameter, coriaceous, whitish gray; lobes rotund, rather narrow, 4–8 mm. wide, crowded, margins crenate, often ascending, sorediate, soralia linear to subglobose, ciliate, cilia sparse to conspicuous, 0.5–1.5 mm. long, rather coarse; upper surface opaque, often pruinose, irregularly cracked with age, often capitate-sorediate near the margins, coalescing with the marginal soredia; lower side black and rhizinate at the

center, dark brown and naked or in part papillate along the margins. Apothecia rare, adnate, to 4 mm. in diameter, disc perforate; hymenium 50–60 μ high; spores 5–7×12–14 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

Parmelia grayana is a saxicolous species with wide distribution in Asia and Africa (fig. 19). It is superficially like *P. praesorediosa* Nyl., which is sometimes saxicolous but lacks cilia. The thallus of *P. grayana* is usually coriaceous, the upper cortex white pruinose, and the cilia thick and coarse.

Additional specimens examined:

UNION OF SOUTH AFRICA: Transvaal: Pretoria, *Smith* 6276 (PRE); Punch Bowl Inn, *Almborn* 6483 (LD, US); Louis Trichardt, Zoutpansberg, *Almborn* 6098 (LD); Natal: Indumeni Forest, Cathedral Peak Area, *Almborn* 8929 (LD, US); 1 mi. west of Cathedral Peak Hotel, Bergville Distr., *Almborn* 9130 (LD); Cape Province: Mataliele, *Höeg* s.n. (TRH).

JAPAN: Mt. Buzan, Shimoda, Prov. Izu, *Kurokawa* 58630 (TNS, US).

57. Parmelia hololoba Hale, sp. nov.

Thallus laxe adnatus vel suberectus, rigidiusculus, usque ad 10 cm. diametro, albicans, parum lobatus, lobis magnis, rotundatis, 10–20 mm. latis, margine sinuatis, ciliatis, ciliis 1.0 mm. longis, superne opacus, laevigatus, leviter rimosus in aetate, cortice continuo, strato corticeo superiore 12–16 μ crasso, strato gonidiali 10–15 μ crasso, medulla alba, 70–85 μ crassa, strato corticeo inferiore 8–10 μ crasso, inferne niger, sparse rhizinosus, margine castaneus, late nudus. Apothecia 5–10 mm. diametro, pedicellata, disco perforato, amphithecio albo-maculato in aetate; hymenium 60–70 μ altum; sporae 7–8×10–12 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K−, C+ rubra, KC+ rubra, P−, atranorinum et acidum lecanoricum continens.

Type in the Kew Herbarium, collected at Entebbe, Uganda, Africa, Mar. 3, 1959, by Proctor (packet A; isotype in US).

Although *P. hololoba* is known only from the type locality, the material is well developed and exhibits a unique combination of characters. The presence of cilia in a species with lecanoric is particularly unusual. It is probably near *P. cooperi* Stein. & Zahlbr., which is sorediate, and may eventually prove to be the nonsorediate phase of this species. Except for the presence of cilia, it is very close to *P. andina* Mull. Arg.

58. Parmelia hypomiltoides Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:35. 1890.

Type collection: Sitio, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs. s.n.* (TUR, Vain. herb. no. 2543, holotype).

Thallus loosely adnate, membranaceous, 5–8 cm. in diameter, mineral gray; lobes rotund, margins entire to incised, ciliate, cilia 1.5–2.5 mm. long, sorediate, soredia granular; upper surface shiny, faintly maculate, sorediate near the margins, soralia at first punctiform, granular, coalescing irregularly, developing short subisidial growths; lower side black and sparsely rhizinate, brown and rugulose, naked, in a zone along the margin. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish orange, P−, in part orange red, reacting K+ purple, atranorine, alectoronic acid, and an unknown anthraquinone present.

The type of *P. hypomiltoides* is a very poor fragment. The chief diagnostic characters are the orange-red medulla, quite conspicuous even near lobe tips, and the coarsely sorediate or even isidiate-sorediate laminal and submarginal soralia. By chromatography it is possible to show that the red pigment is not rhodophyscin, which is otherwise so common in *Amphigymnia* species with alectoronic acid. It is an unnamed pigment (No. 1) also found in *P. erasmia* Hale and *P. mesogenes* Nyl. *Parmelia hypomiltoides* could be confused with *P. rampoddensis* Nyl. which has rhodophyscin and marginal farinose soredia or with *P. mellissii* Dodge which also has rhodophyscin and distinct sorediate-isidia. In both of the latter species the pigment is associated with older or decomposed parts of the medulla, but it is still desirable to make chromatographic tests. *Parmelia hypomiltoides* is extremely rare and confined to southern Brazil, although it will probably be found eventually in Central America.

Additional specimen examined:

BRAZIL: São Paulo: Cruzeiro, *Robert*, November 1900 (BM).

59. Parmelia inexspectata des Abbayes, Bull. Inst. Fr. Afr. Noire 20:16. 1958.

Type collection: Mt Tonkoui, cercle de Man, Ivory Coast, *des Abbayes* (REN, holotype; US, isotype).

Thallus to 10 cm. broad, loosely attached, mineral gray; lobes rotund, 10–15 mm. wide, margins subcrenate, ciliate, cilia 3–6 mm. long, upper surface plane, dull, soredia and isidia lacking, lower side black and sparsely rhizinate, brown and naked in a broad zone at the margins. Apothecia (from original description) to 15 mm. in diameter, pedicellate, exciple entire to dentate, amphithecium rugose, disc imperforate; spores 11–14×23–28 μ.

Reactions: Thallus K+ yellow; medulla K+ orange red, C−, KC−, P−, atranorine and an unidentified K+ substance present.

This species is characterized by a P−, K+ medullary reaction. As des Abbayes (1958) has pointed out, *P. eurysaca* Hue is somewhat similar in general appearance but contains salacinic acid, and, we might add, has perforate apothecia and small spores. Actually

P. inexpectata seems to have no close relatives and more collections must be seen before we can assess the range of variation.

Additional specimens examined:

IVORY COAST: Near Cinchona station, Mont Tonkoui cercle de Man, *Santesson* 10618b, 10619a (UPS).

60. Parmelia lophogena des Abbayes, Bull. Inst. Fr. Afr. Noire 20:19. 1958.

Type collection: Dalaba, Fouta-Djalon, Guinea, Africa, *des Abbayes* (REN, holotype; US, isotype).

Thallus loosely adnate on bark, 5–8 cm. broad, mineral gray; lobes rotund, 7–10 mm. wide, margins entire, ciliate, cilia 1.0–1.5 mm. long; upper surface shiny, plane, continuous, densely lobulate-isidiate, isidia inflated, pustulate, irregular, 0.2–0.3 mm. thick, to 0.5 mm. high, fragile; lower side black and moderately rhizinate, pale brown to mottled ivory in a broad zone at the margins. Apothecia poorly developed, spores not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ blood red, P−, atranorine and gyrophoric acid present.

The more or less lobulate pustulate isidia set *P. lophogena* apart from all other species of *Amphigymnia*. It is still known only from the type collection.

61. Parmelia maclayana Müll. Arg. Flora 74:376. 1891. PLATE 7

Type collection: South of Tropic of Capricorn, Africa, *Maclay* (K, holotype; G, isotype).

Thallus loosely attached, more or less coriaceous, 6–10 cm. in diameter, mineral gray; lobes rotund, 10–15 mm. wide, margins entire, become short, coarsely digitate-lobulate toward the center, ciliate, cilia rather sparse, to 2 mm. long, more common on lateral margins; upper surface plane, dull or rather shiny, very faintly maculate in part, continuous to more or less cracked with age; isidia and soredia lacking; lower side black, sparsely rhizinate, brown to tan and naked in a broad zone along the margins. Apothecia substipitate, 8–12 mm. in diameter, amphithecium maculate, rugulose, disc perforate; hymenium 50–70 μ high; spores 6–10×12–15 μ, episporium 1.0–1.5 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange red, P−, atranorine and alectoronic acid present.

Parmelia maclayana is differentiated from three other nonsorediate African *Amphigymnia* species containing alectoronic acid (*P. breviciliata* Hale, *P. procera* Stein. & Zahlbr., and *P. wainii* A. L. Sm.) by perforate apothecia. *Parmelia ornatula* Hale is saxicolous and has dense cilia. *Parmelia maclayana* is known only from three widely separated localities in Africa.

Additional specimens examined:

SIERRA LEONE: Kaballa, *Thomas* 2192 (K). TANGANYIKA: Peramiho, *Dietrich* s.n. (M).

62. Parmelia margaritata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:193. 1899. PLATE 9

Type collection: Ohio, *Sullivant* (P, lectotype).

Thallus loosely attached, 5–15 cm. in diameter, corticolous, mineral gray; main lobes rotund, 7–10 mm. wide, soon branching irregularly and developing numerous marginal laciniae, 1.5–2.0 mm. wide, 3–5 mm. long, margins sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface dull to shiny, faintly maculate, reticulately cracked with age, sorediate, soralia originating near the tips of laciniae in orbicular groups, coalescing into extensive irregular soralia, sorediate lobes usually becoming revolute; lower side black and sparsely rhizinate, dark brown and naked in a broad or rather narrow zone at the margins. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

The soralia of *P. margaritata* originate on the surface of small marginal laciniae, eventually extending to the margins and causing the laciniae to become revolute. It is virtually identical therefore with *P. arnoldii* Du Rietz except for the more restricted distribution (fig. 9) and different chemistry. These two species have quite different distribution patterns in the deciduous forests of eastern United States, *P. margaritata* being more common in mesic forests and *P. arnoldii* being more common at higher elevations.

Additional specimens examined:

U.S.: MASSACHUSETTS: Seavern's Woods, *Faxon* s.n. (DUKE); PENNSYLVANIA: Conewago, Lancaster Co., *Heller* s.n. (US); DISTRICT OF COLUMBIA: Rock Creek, *Miller* 116 (US); WEST VIRGINIA: Pineville, Wyoming Co., *Hale* 11861 (US); OHIO: Near Cincinnati, *Lea* 14 (PH); MARYLAND: Red Run, Baltimore Co., *Plitt* 233 (BPI); KENTUCKY: Stanton, Powell Co., *Prescott* 66 (WIS); 6 mi. southwest of London, Laurel Co., *Reed* 58147 (Reed Herbarium); WISCONSIN: Coon Valley, Vernon Co., *Thomson* 1907 (WIS); IOWA: Fayette Co., *Fink* s.n. (US); VIRGINIA: Browntown Valley Overlook, Skyline Drive, Rappahannock Co., *Hale* 14734 (US); 2 mi. east of Buena Vista, Rockbridge Co., *Hale* 18263 (US); Hone Quarry, Rockingham Co., *Hale* 18212 (US); near Evington, Campbell Co., *Hale* 15993 (US); Mountain Lake, Giles Co., *Hale* 12671 (US); 6 mi. east of Burnt Chimney, Franklin Co., *Hale* 15940 (US); NORTH CAROLINA: 12 mi. northeast of Pinnacle, Stokes Co., *Culberson* 6336 (DUKE); 8 mi. east of Weaverville, Buncombe Co., *Culberson* 7161 (DUKE); 3 mi. east of Lenoir, Caldwell Co., *Culberson* 7224 (DUKE); between Sands and Meat Camp, Watauga Co., *Culberson* 5982 (DUKE); TENNESSEE: Cliff Springs, Overton Co., *Phillips* s.n. (US); ARKANSAS: Eureka Springs, Carroll Co., *Hale* 2755 (US); 8 mi. south of Hollis, Perry Co., *Hale* 3097 (US); Mt. Ida, Montgomery Co., *Hale* 3035 (US); near Dallas, Polk Co., *Hale* 3957 (US); Ponca, Newton Co., *Hale* 2820 (US); Gateway, Benton Co.,

Hale 4010 (US); Mt. Magazine Park, Logan Co., *Hale* 3419, 3442 (US); Mountainburg, Crawford Co., *Hale* 2669 (US).

63. Parmelia mellissii Dodge, Ann. Mo. Bot. Gard. 46:134. 1959. PLATE 1

Parmelia crinita var. *inactiva* Magn. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:104. 1944. Type collection: Between Haelaau and Nakalalua, Maui, Hawaii, *Selling* 5801 (S, holotype).

P. allardii Hale, Bryol. 62:123. 1959. Type collection: Constanza, La Vega, Dominican Republic, *Allard* 16529 (US, holotype).

Type collection: St. Helena, *Melliss* 23 (K, holotype).

Thallus loosely adnate, corticolous, light mineral gray, 5–10 cm. broad; lobes rotund, 6–12 mm. wide, margins crenate to isidiate and dissected, ciliate, cilia 1–3 mm. long, KOH+ blue or K—; upper surface plane, dull, isidiate, especially near the margins, or sorediate-isidiate, isidia eventually becoming granular and sorediate, at maturity densely coralloid branched and ciliate, up to 3 mm. high; medulla white or in part reddish orange near the lower cortex; lower side black and rhizinate, naked and brown to tan or mottled white in a broad zone near the margins. Apothecia very rare, to 5 mm. wide, disc imperforate; hymenium 80–90 μ high; spores 10–14×16–22 μ; episporium 1.5–2.0 μ; pycnidia and conidia lacking.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ red or orange red, P—, pigmented medulla K+ purple, atranorine, alectoronic acid, and frequently rhodophyscin present.

Dodge's type specimen, although poorly developed, has typical coralloid sorediate isidia. The medullary reaction that he gives, KC—, is erroneous since alectoronic acid is present. His specimen lacks the pigment rhodophyscin which is present in about half of the specimens examined, especially those that show signs of decay. Rhodophyscin appears to be produced whenever the thallus ages or begins to disintegrate and seemingly has no taxonomic value.

Parmelia mellissii is pantropical with northward extensions into temperate United States and Japan. It had been identified as *P. arnoldii* Du Rietz in Japan because most specimens, as in the United States, are predominantly coarsely sorediate-isidiate. The range of variation from distinct coralloid isidia with scant development of soredia to the sorediate phase is very great and cannot be easily classified. Confusion with *P. arnoldii* and even *P. rampoddensis* Nyl. is possible, but the origin and type of soredia separate these species.

Additional specimens examined:

U.S.: TENNESSEE: Fall Creek Falls, Van Buren Co., *Phillips* 348 (US); SOUTH CAROLINA: Honey Hill, Berkeley Co., *Culberson* 10300 (DUKE); GEORGIA: Near Chatsworth, Murray Co., *Hale* 7439 (US); ALABAMA: Bankhead National Forest, Winston Co., *McCullough* 574 (US); FLORIDA: 6 mi. southwest of Talla-

hassee, Leon Co., *Hale* 16986 (US); Alum Bluff, Apalachicola River, Liberty Co., *Thomson* 5144 (WIS); TEXAS: Pineland, Sabine Co., *Hale* 5161 (US). MEXICO: CHIAPAS: Lagos de Monte Bello, *Hale* 20961 (DUKE, MSC, REN, TNS, US); El Suspiro, 10 km. north of Berriozábal, *Hale* 20235 (S, US). GUATEMALA: SAN MARCOS: Barranco Eminencia, *Standley* 86498 (MO). HONDURAS: MORAZÁN: Lower slopes of Cerro de Uyuca, *Standley* 12034 (F). COSTA RICA: Cuesta de Terraza, *Tonduz* s.n. (G).

CUBA: ORIENTE: Gran Piedra, Sierra Maestra, *Imshaug* 25044 (MSC, US). HAITI: Eastern end of Montagne Noire, near Kenscoff, *Imshaug* 22541 (MSC, US); vicinity of Forêt des Pins, SHADA Station, *Wetmore* 3212 (MSC, US), 2925, 3074 (MSC), *Imshaug* 22756 (MSC, US); summit of Pic La Selle, *Imshaug* 22982 (MSC, US), *Wetmore* 3130 (MSC). DOMINICAN REPUBLIC: Summit of Isabel de Torres, near Puerto Plata, *Imshaug* 23927 (MSC); southwest slope of La Rucilla, Maciso Central, *Imshaug* 23595 (LD, MSC, US); between Pico del Yaque and Chinguela, Cordillera Central, *Wetmore* 3698, 3735 (MSC, US). JAMAICA: Without locality, *Cummings* 43 (FH, NY); Abbey Green Woodland, *Harris* 10028 (BM); Hollymount, Mt. Diablo, *Imshaug* 14235 (MSC, US); Sir Johns Peak, Blue Mountains, *Imshaug* 15175 (MSC). PUERTO RICO: Adjuntas, *Sintenis* 99, 110a (G). MARTINIQUE: Piton Dumauzé, *Degelius* s.n. (DEGEL).

COLOMBIA: Vicinity of Medellín, *Charetier* 188 (US); San Isabel, s.c. (G). BRAZIL: Minas Gerais, *Warming* 272 (M).

CANARY ISLANDS: Teneriffe, *Cook* 1130 (US).

INDIA: Above Kurseong, Darjeeling, *Awasthi* 3923 (AWAS). LAOS: Hase Plantations, *Tsuyama* 1 (TNS). CHINA: Near Yunnanfu, Yunnan, *Handel-Mazzetti* 66 (WU). JAVA: Gegerbentang, *Neervoort* 3048 (BO); Tjinjiroea, *Van Slooten* s.n. (BO). JAPAN: TANJO-JI: Kominato, Prov. Awa, *Kurokawa* 56572 (TNS, US); Matsukawa-ura, Prov. Iwaki, *Kurokawa* 58088 (TNS, US).

Additional records from the United States, Cuba, Jamaica, Venezuela, and Formosa listed by Hale (1959b) as *P. allardii* are not repeated here.

64. Parmelia merrillii Vainio, Phil. Journ. Sci. 4:658. 1909 PLATE 8

Type collection: Mt. Halcon, Mindoro, Philippine Islands, *Merrill* 6163 (TUR, lectotype).

Thallus large, loosely attached, 8–10 cm. in diameter, mineral gray; lobes 10–15 mm. wide, rotund, margins laciniate toward the center of the thallus, laciniae 0.5–1.0×2–5 mm., sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface dull, reticulately cracked with age, isidia and soredia lacking; lower side black, sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia abundant, 4–10 mm. in diameter, exciple dentate-laciniate, ciliate, amphithecium rugose, white-maculate, disc imperforate; hymenium 90–110 μ high; spores 12–16×26–34 μ, episporium 2.5–3.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ orange red, P+ brick red, atranorine and protocetraric acid present.

Parmelia merrillii has long narrow laciniae on the lobes and frequently on the exciple of the apothecia. It could be confused superficially with *P. corniculans* Nyl., another Asian species, which differs

chiefly in chemistry (alectoronic acid present) and in having perforate apothecia. *Parmelia pachyspora* Hale, an African species, has similar chemistry and large spores, but differs in having sparse cilia and in lacking distinct marginal laciniae.

Additional specimens examined:

BOLIVIA: Cochabamba: Schuenca-Carrasco, *Cardenas* 5284 (US).
FORMOSA: Chokakurai, *Masuda* F.546 (TNS, US). BORNEO: Marai Parai, Mt. Kinabalu, *Clemens* 32425 (BO). CELEBES: B. Watoewila, *Kjellberg* 41L (BO). SUMATRA: Batang Paloepoeh, *Jacobson* s.n. (BO). JAVA: S.l., *Horsfield* (BM).

65. Parmelia ornatula Hale, sp. nov. Plate 10

Thallus adnatus, saxicola, 5–10 cm. diametro, albicans vel cinereo-albicans, lobis rotundatis, contiguis, elongatis, 4–7 mm. latis, margine suberectis, crenatis, dense ciliatis, ciliis suberectis, 1–2 mm. longis, sorediis isidiisque destitutis, superne nitidus, continuus, planus vel late concavus, irregulariter rimosus in aetate, strato corticeo superiore 13–17 μ crasso, strato gonidiali 15–26 μ crasso, medulla alba, 50–65 μ crassa, strato corticeo inferiore 13–15 μ crasso, subtus niger, modice rhizinosus, ambitu castaneus, anguste nudus. Apothecia pedicellata, 4–7 mm. diametro, excipulo ciliato, amphithecio rugoso, albomaculato, disco perforato; hymenium 40–50 μ altum; sporae 5–7×10–13 μ, episporio 1.5 μ; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K−, C−, KC+ rubescens, P−, atranorinum et acidum alectoronicum continens.

Type in herbarium of Gunnar Degelius, collected near Faz. Canjangue, Vila Flor, Huambo, Angola, Africa, Feb. 18, 1960, by G. Degelius (isotype in US).

This is a saxicolous species with rather narrow crowded lobes and dense suberect marginal cilia, as well as a few laminal cilia. It would appear to be a distant relative of another saxicolous species with alectoronic acid, *P. breviciliata* Hale, which is a larger species with imperforate apothecia. *Parmelia ornatula* is known only from the type collection and is probably endemic to Angola.

66. Parmelia pachyspora Hale, sp. nov.

Thallus laxe adnatus, expansus, 12–20 cm. diametro, cinereo-albicans, lobis rotundatis, 10–15 mm. latis, margine plus minusve crenatis, saepe dentato-laciniatis, suberectis, sparse ciliatis, ciliis 1.0–2.5 mm. longis, sorediis isidiisque destitutis, superne opacus, planus, continuus vel irregulariter rimosus, strato corticeo superiore 13–17 μ crasso, strato gonidiali 20–26 μ crasso, medulla alba, 75–100 μ crassa, strato corticeo inferiore 15–18 μ crasso, inferne niger, sparse rhizinosus, ambitu castaneus vel eborinus, late nudus. Apothecia pedicellata, 5–8 mm. diametro, excipulo plus minusve ciliato-dentato,

amphithecio valde rugoso atque albomaculato, disco imperforato; hymenium 80–90 μ altum; sporae 13–15×30–34 μ, episporio 3 μ crasso; pycnidia numerosa, conidiis 1×5–6 μ. Thallus K+ flavescens; medulla K−, C−, KC+ rosea, P+ aurantiaca, atranorinum et acidum protocetraricum continens.

Type in the herbarium of Gunnar Degelius, collected 10 km. north of Sá da Bandeira, Huila, Angola, Africa, Feb. 3, 1960, by G. Degelius (isotype in US).

The apothecia of *P. pachyspora* are stalked and conspicuous. The closest related species is *P. merrillii* Vain., an Asian species with long marginal laciniae. *Parmelia pachyspora* is known from several localities in southern Africa.

Additional specimens examined:

ANGOLA: Moxico: Between Luso and Cochipoque, *Degelius*, Feb. 16, 1960 (DEGEL); Cuanza Sul: Amboim, *Gossweiler* 10006 (BM). NYASALAND: Kyimbila, *Stolz* 2760 (C); Mt. Massangulo, *Gomez* 8 (K). SOUTHERN RHODESIA: Salisbury, *Moss* 2217 (PRE). MOÇAMBIQUE: Nampula Distr., *Gomes* 2134 (PRE).

67. Parmelia perlata (Huds.) Ach. Meth. Lich. 216. 1803.

Lichen perlatus Huds. Fl. Angl. 448. 1762.

Parmelia coniocarpa Laurer, Linnaea 2:39. 1827. Type collection: Australia, *Sieber* 50 (M, holotype; S, isotype).

P. coriacea var. *perlata* (Huds.) Eschw. *in* Mart. Fl. Bras. 1:206. 1833.

P. schweinfurthii f. *sorediata* Müll. Arg. Flora 70:59. 1887. Type collection: East Gippsland, Australia, *Walter* (M, holotype; G, isotype).

P. trichotera Hue, Journ. de Bot. 12:245. 1898. Type collection: France, *Malbranche, Lich. Norm.* 65 (P, lectotype; DUKE, isotype).

P. piloselloides Zahlbr. Svensk. Vet. Akad. Handl. 57, no. 6:43. 1917. Type collection: Masatierra, Cumberland Bay, Juan Fernandez, *Skottsberg* (W, holotype; S, isotype).

P. protosorediata Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. schweinfurthii* f. *sorediata* Müll. Arg.

P. cristifera f. *pallida* Räs. Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo 3:3. 1944. Type collection: Carrasco, Montevideo, Uruguay, *Herter*, 1929 (H, holotype).

Type collection: Specimen and *pl. 20, fig. 39B*, Dillenius Hist. Musc. 147. 1741 (OXF, lectotype).

Thallus adnate to loosely attached, 5–15 cm. in diameter, mineral gray; lobes 8–15 mm. wide, margins entire, ciliate, cilia sparse, 0.3–2.0 mm. long, submarginally sorediate, soredia originating in linear soralia, soon eroding a large area and causing the margins to become strongly revolute; upper surface smooth, opaque; lower side black and moderately rhizinate, dark brown, shiny, and naked in a broad to narrow zone along the margins. Apothecia very rare, 3–5 mm. in diameter, disc imperforate; hymenium 70–80 μ high; spores 13–16× 22–30 μ, episporium 3 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ persistent yellow, C−, KC−, P+ pale orange yellow, atranorine and stictic acid present.

I recently made a study (1961) of the typification of this common species in order to stabilize its name. The diagnostic characters are the conspicuous submarginal soralia, revolute lobes, and the presence of stictic acid. Specimens from Juan Fernandez named as *P. piloselloides* Zahlbr. have more extensive sublaminal soredia than normal but still fall within the range of *P. perlata*. The narrow, shiny and often rugose naked zone below suggests a relationship between *P. perlata* and isidiate *P. crinita* Ach., which also produces stictic acid. *Parmelia perlata* is widespread in temperate regions of all continents (fig. 20). In Scandinavia it is an oceanic species (Almborn, 1948) with a distribution pattern similar to that of *P. arnoldii* Du Rietz and *P. crinita* Ach.

Additional specimens examined:

CANADA: Nova Scotia: Hunt's Point, *Denison* (US); Uclucet, Vancouver Island, *Macoun, Canad. Lich.* 44 (DUKE). U.S.: Pennsylvania: 2 mi. east of Worlds End State Park, Sullivan Co., *Hale* 17226 (US); West Virginia: Near West Union, Doddridge Co., *Hale* 10385 (US); Wellford, Kanawha Co., *Hale* 10862 (US); Kentucky: Near Baldrock, Laurel Co., *Reed* 58118 (Reed Herbarium); Virginia: 1 mi. north of Gillespie, Bedford Co., *Hale* 15762 (US); Whitetop Mountain, Washington Co., *Hale* 18490 (US); Tennessee: Near Elkmont, Sevier Co., *Cain* 85 (US); Cliff Springs, Overton Co., *Phillips* 313 (US); North Carolina: Near Yadkin Valley, Caldwell Co., *Culberson* 6507 (DUKE, US); near Candler, Buncombe Co., *Green* s.n. (US); summit of Mt. Mitchell, Yancey Co., *Imshaug* 22358 (MSC); Georgia: 5 mi. east of Hiawassee, Towns Co., *Culberson* 7289, 7264 (DUKE); Oregon: Cape Blanco, Port Oxford, *Imshaug* 17655 (MSC); California: Freshwater, Humboldt Co., *Becking* 61060012 (US); Woodside, San Mateo Co., *Cain* 26378 (TRT, US); Point Reyes, Marin Co., *Imshaug* 17686 (MSC). MEXICO: San Luis Potosí: Alvarez, *Palmer* 467 (US); Hidalgo: 20 mi. southwest of Jacala, *Cain* 27619 (TRT, US); Puebla: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19645 (US); Mexico: La Cima, *Pringle* 10725 (US); Veracruz: 33 km. northeast of Perote, *Hale* 19354 (US). PANAMA: Chiriquí: Chiriquí volcano, *Scholander* s.n. (MO).

HAITI: Summit of Tête Étang, *Imshaug* 22614 (MSC), 22620 (MSC, US).

CHILE: Juan Fernandez, *Skottsberg* s.n. (S), s.c. (K); Coquimbo: Fray Jorge, *Sparre* 3020 (S); Valparaiso: Lago Peñuelas, *Santesson* 7002 (S); Valdivia: Corral, *Santesson* 7064 (S); Lago Riñihue, *Santesson* 3511; Cautín: Temuco, *Gunckel* 18204 (MO); Chiloé: Ancud, Isla Chiloé, *Santesson* 4234 (S); Laraquete, *Hosseus* 75 (M).

IRELAND: Galway, *Degelius* s.n. (UPS). SCOTLAND: Between Salen and Drumlang, Argyll, *Lindahl* 95d (UPS). ENGLAND: Bilsdale, Yorkshire, *Baker* s.n. (US). NORWAY: Seljuåsen, Sokndal, *Santesson* s.n. (US).

NETHERLANDS: Goes, Zeeland, *Maas Geesteranus* s.n. (US). POLAND: Puszcza Bukowa, *Glanc, Lich. Polon.* 173 (LD). FRANCE: St. Thurial, Ille-et-Vilaine, *Santesson* 10080 (US); Rennes Woods, *des Abbayes, Lich. Armor. Spect. Exs.* 107 (LD); Le Trayas, Estrel, *Suza, Crypt. Exs. Vind.* 3657 (US);

Troyes, *Culberson* 1026 (DUKE, US). SPAIN: South of the Santuario, Covadonga, *Santesson* 13085b (UPS). PORTUGAL: Near Azoia, Estremadura, *Tavares, Lich. Lus. sel. Exs.* 141 (LD, US, WIS); Pinhal, Douro Litoral, *Tavares* 4199 (US); Peso, Minho, *Tavares* s.n. (WIS). ITALY: Torriglia, Liguria, *Almborn* s.n. (LD); Arenzano, *Sbarbaro* s.n. (WIS); Veneto, *Mass. Lich. Ital.* 325 (UPS).

AZORES: Santa Maria, *Baldwin* 14196 (US); St. Michel, *Persson* s.n. (UPS). TUNISIA: Ain Draham, *Runemark* s.n. (LD). CANARY ISLANDS: Cumbu Nueva, *Pitard* 2008 (DUKE). MADEIRA: Funchal, *Paton* s.n. (BM). TRISTAN DA CUNHA: Gong Island, *van der Merwe* 51a (LD). KENYA: Tinderet Forest Reserve, Kisumu-Londiani, Nyanza Prov., *Maas Geesteranus* 11167 (L). UNION OF SOUTH AFRICA: TRANSVAAL: Houtbosch, Pietersburg, *Almborn* 6768 (LD); NATAL: Polela Forest, Polela, *Almborn* 9514 (LD, US); Upper Umkomaas, Impendhle Distr., *Höeg* s.n. (TRH); CAPE PROVINCE: 3 mi. west of Heidelberg, Swellendam, *Höeg* s.n. (TRH); Kirstenbosch, Wynberg, *Almborn* 1389 (LD).

JAPAN: Mt. Oodake, Musashi, *Kurokawa* 59147 (TNS, US); Shikkari, Prov. Mutsu, *Kurokawa* 550310 (TNS, US). HAWAIIAN ISLANDS: Kauai, *Kraus* 1128 (Darrow Herbarium). AUSTRALIA: Illawarra, New South Wales, *Kirton* s.n. (BM). NEW ZEALAND: Plymouth, *Thomson* s.n. (BM); Wellington, *Buchanan* s.n. (BM).

68. Parmelia permutata Stirton, Scot. Nat. 4:252. 1877–78.

Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype; GLAM, isotype).

Thallus 5–15 cm. broad, loosely attached, mineral gray; lobes rotund, 8–15 mm. wide, margins often suberect, entire, ciliate, cilia 2.0–4.5 mm. long, sorediate, soralia elongate, sinuous, rarely submarginal; upper surface smooth, opaque, reticulately cracked with age; medulla white in upper half, becoming orange yellow in lower half; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigment K−, atranorine, gyrophoric acid, and an unidentified yellow pigment present.

Parmelia permutata has a pale orange-yellow medulla with the same pigments that are found in *P. araucariarum* Zahlbr., *P. myelochroa* Hale, and others. In *P. permutata* the pigments are definitely localized in the lower half of the medulla and the upper half is white. When pigments are heavily concentrated in *P. sancti-angelii* Lynge, which is also C+ rose, it is easy to confuse these two species, but the pigment in *P. sancti-angelii* is rhodophyscin, which reacts K+ purple. *Parmelia rampoddensis* Nyl., which is C−, KC+ red (alectoronic acid), is also very similar externally and may produce rhodophyscin. In doubtful cases chromatography should be used to identify the pigments. *Parmelia permutata* is a rather rare species known only from Australia, Africa, and Asia and a single locality in the West Indies.

Additional specimens examined:

HAITI: Near Furcy, *Bro. Fabius*, July 1962 (US).

IVORY COAST: Danané, cercle de Man, *des Abbayes*, Oct. 19, 1951 (TUR). KENYA: NYANZA: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4954, 4956 pr. p. (L). UNION OF SOUTH AFRICA: NATAL: Pietermaritzburg, *Almborn* 9633 (LD); TRANSVAAL: Near "Punch Bowl," Louis Trichardt, Zoutpansberg, *Almborn* 6245 (LD).

INDIA: Darjeeling, *Thomson*, s.d. (GLAM). THAILAND: Hase, *Tsuyama* 20 (TNS). SUMATRA: Between Lubuk Selasih and Aer Batumbuk, *Groenhart* 9355 (BO).

69. Parmelia procera Stein. & Zahlbr. Bot. Jahrb. Engler 60:537. 1926.

PLATE 10

Type collection: Near Amani, Tanganyika, *Brunnthaler*, August 1890 (W, lectotype).

Thallus large, 10–15 cm. in diameter, coriaceous, loosely attached, buff, mineral gray; lobes rotund, 8–15 mm. wide, often becoming convoluted and crowded toward the center, margins smooth or becoming short lobulate-dentate or laciniate, laciniae suberect, sparsely to moderately ciliate, cilia 2–4 mm. long; upper surface smooth, at length finely reticulately cracked, faintly maculate at the base of apothecia; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia very large, to 30 mm. in diameter, stalked, amphithecium maculate, disc imperforate; hymenium 60–70 μ high; spores 5–6$\times$12–16 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Parmelia procera belongs to that variable difficult group of nonsorediate, nonisidiate species with alectoronic acid. It differs from *P. maclayana* Müll. Arg. and *P. ornatula* Hale in having imperforate apothecia. *Parmelia breviciliata* Hale is saxicolous, and *P. wainii* A. L. Sm. has long cilia and intermediate spores.

Additional specimens examined:

TANGANYIKA: Amani, *Greenway* 1001 (K). MOÇAMBIQUE: Massangulo *Sandrone* (F). NYASALAND: Mt. Massangulo, *Sousa* 8 (K). ANGOLA: Capir, Cuanza Sul, *Gossweiler* 9907 (US).

THAILAND: Doi Sutep, *Tsuyama* 7 (TNS, US).

NEW CALEDONIA: *Compton* 1471 (BM).

70. Parmelia pseudocrinita des Abbayes, Bull. Inst. Fr. Afr. Noire 20:19. 1958.

Parmelia braunii Dodge, Ann. Mo. Bot. Gard. 46:135. 1959. Type collection: Tanganyika, *Braun, Inst. Amani* 8603 (EA, holotype).

P. mannii Dodge, Ann. Mo. Bot. Gard. 46:136. 1959. Type collection: Ilha Principe, Africa, *Mann*, 1861 (K, holotype).

Type collection: Dalaba, Fouta-Djalon Mountains, Guinea, *des Abbayes*, Feb. 5, 1951 (REN, lectotype; US, isotype).

Thallus large, 10–15 cm. in diameter, rather coriaceous, loosely attached, mineral gray; lobes rotund, 8–12 mm. wide, margins crenate, ciliate, cilia coarse, 1–2 mm. long, upper surface smooth, dull, becoming rugulose or fissured on older lobes, isidiate, isidia simple to rarely coralloid branched, 0.05–0.07×0.2–0.5 mm., rarely ciliate apically; medulla white, rarely orange red near the lower cortex; lower side black and sparsely rhizinate, brown, shiny, and naked in a broad zone at the margins. Apothecia rare, short stalked, 2–3 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 50–65 μ high; spores 7–8×11–13 μ, episporium 1 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigmented medulla K+ purple, atranorine, gyrophoric acid, and (if pigmented) rhodophyscin present.

Parmelia pseudocrinita is a rather common lichen in southern Africa. The overall external appearance reminds one at once of *P. crinita* Ach., but the cilia are coarse, the spores small, and the medulla K−, C+ rose.

Additional specimens examined:

ANGOLA: Huila: Between Coporolo and Chingorvi, *Degelius*, Feb. 2, 1960 (DEGEL); Bié: Coemba, *Degelius*, Feb. 10, 1960 (DEGEL). CONGO: 15 km. west of Goma, Goma, North Kivu, *Degelius*, Mar. 16, 1960 (DEGEL); Yangambi, Luweo Plateau, *Louis* 8151, 8155 pr. p. (BR); north of Elisabethville, *Höeg*, Apr. 16, 1930 (TRH). SOUTHERN RHODESIA: Matopos, *Borle* 54a (PRE). UNION OF SOUTH AFRICA: Near Solheim, Eschowe (Zululand), *Höeg*, Sept. 5, 1929 (TRH); Natal: 1 mi. north of Umzumbi, Umzinto, *Almborn* 9870 (LD).

71. Parmelia rampoddensis Nyl. Acta Soc. Sci. Fenn. 26, no. 10:7. 1900.

Parmelia proboscidea var. *sorediifera* Müll. Arg. Flora 67:615. 1884. Type specimen: Central Madagascar, *Hildebrandt* (G, lectotype).

P. proboscidea f. *sorediifera* (Müll. Arg.) Müll. Arg. Bull. Soc. Bot. Belg. 30:53. 1891.

P. proboscidea f. *bulbifera* Huc, Nouv. Arch. Mus. Paris, ser. 4, 1:197. 1899. Type collection: Coonoor, Nilgherries, India, *Gray*, 1883 (P, holotype).

P. poolii Dodge, Ann. Mo. Bot. Gard. 46:146. 1959. Based on *P. proboscidea* var. *sorediifera* Müll. Arg.

P. subinvoluta Hale, Bryol. 62:130, *fig. 4*. 1959. Type collection: 4 mi. west of Midway, Liberty Co., Georgia, *Hale* 16807 (US, holotype).

Type collection: Ramboda, Ceylon, *Almquist* (H, Nyl. herb. no. 35555, holotype; S, isotype).

Thallus large, expanded, 10–30 cm. wide, loosely attached, whitish to mineral gray; lobes broad and rotund, 12–20 mm. wide; margins entire, sorediate, soralia linear, 0.2–0.5 mm. wide, sorediate margins more or less involute, ciliate, cilia conspicuous, 3–6 mm. long; upper surface plane, rugulose with age; medulla white, often in part orange red near the lower cortex; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia rare, 3–10 mm. in diameter, amphithecium sorediate, disc imperforate;

hymenium 65–75 μ high; spores 6–7×10–12 μ, episporium 1 μ; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, pigmented medulla K+ purple, atranorine, alectoronic acid and (if pigmented) rhodophyscin present.

After describing *P. subinvoluta*, I had an opportunity to examine the type of *P. rampoddensis* Nyl. from Ceylon, which proved to be identical. Further collections of the species were soon found. It is in reality a pantropical lichen, although most common in southern United States and the Caribbean area. Rhodophyscin is found in a small percentage of the specimens. When the pigment is abundant, one might identify a specimen as *P. hypomiltoides* Vain., which differs in having more or less submarginal isidiate soredia and a different anthraquinone.

Additional specimens examined:

U.S.: North Carolina: 5 mi. east of Calypso, Duplin Co., *Culberson* 6675 (DUKE); South Carolina: 3 mi. northeast of Darlington, Darlington Co., *Culberson* 7648 (DUKE); Alabama: Pocosin area 4 mi. southeast of Troy, Pike Co., *McCullough* 492 (US); Florida: Tomoka State Park, Volusia Co., *Hale* 17062 (US); 5 mi. east of Greenville, Madison Co., *Hale* 17615 (US); Crewsville, Hardee Co., *Hale* 16876 (US); Louisiana: Near Alexandria, Rapides Parish, *Logan* 881b (WIS), 881c (MO); Texas: 7 mi. south of Silsbee, Hardin Co., *Whitehouse* 25955 (MO); Jasper, Jasper Co., *Hale* 5416 (US). MEXICO: Oaxaca: 47 mi. south of Oaxaca, *Kramer* 2333 (KANU, US); Veracruz: Mirador, *Purpus* 86 (US); Chiapas: 2 km. north of highway 190 on road to Puebla Nueva, *Hale* 20171, 20185 (US); El Zapotal, Tuxtla Gutiérrez, *Hale* 20004 (US).

HAITI: Eastern end of Montagne Noire, *Imshaug* 22543 (MSC). DOMINICAN REPUBLIC: North of San José de las Matas, Santiago, *Wetmore* 3897 (MSC). JAMAICA: Mandeville, *Cushman* 12 (FH); trail above Mavis Bank Road, St. Andrew, *Imshaug* 14429 (MSC).

COLOMBIA: Antioquía: Medellín, *Daniel* 925 (US). BOLIVIA: 20 km. west of San José de Chiquitos, Santa Cruz, *Cutler* 7071 (F). BRAZIL: Minas Gerais: São João d'el Rey, *Malme* 270 (S).

CAMEROONS: *Staudt* 692 (BM). MOÇAMBIQUE: 2 km. east of Namaacha, Lourenço Marques, *Almborn* 7107 (LD). UNION OF SOUTH AFRICA: Transvaal: Blaauwberg, Pietersburg, *Leemann* 1533 (PRE). MADAGASCAR: Ambatolaona, *Benoist* 326 (LD).

INDIA: Senchal, Darjeeling, *Togashi* s.n. (TNS). FORMOSA: Renegechi, *Asahina* F.55 (TNS, US). NEW GUINEA: Mt. Arfak, *Kostermanns* 3017 (BO). AUSTRALIA: Parramatta, New South Wales, s.c. (BM).

Additional records from the United States, Jamaica, Dominican Republic, and Honduras listed by Hale (1959b) as *P. subinvoluta* are not repeated here.

72. Parmelia rimulosa Dodge, Ann. Mo. Bot. Gard. 46:133. 1959. Plate 1

Type collection: Table Mountain, Cape of Good Hope, Union of South Africa, *MacGillivray* (K, holotype).

Thallus 5–15 cm. in diameter, loosely attached, light mineral gray membranous; lobes rotund 7–12 mm. wide, becoming crowded,

imbricate and convoluted with age, margins entire to dentate-laciniate, ciliate, cilia rather sparse, 2–3 mm. long; upper surface plane, becoming quite rugose, reticulately cracked with age, cortex cracking apart and flaking away in a broad zone along the margins, becoming sorediate or isidiate-pustulate, clearly maculate only at the base of apothecia; medulla white, sometimes orange red near the lower cortex; lower side black and rhizinate, brown to mottled tan and naked in a broad zone along the margins. Apothecia rare, 8–15 mm. in diameter, stalked, amphithecium rugose, maculate, disc perforate; hymenium 70–80 μ high; spores 10–13×20–22 μ, episporium 1.5–2.0 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, sometimes pigmented orange red near the lower cortex, K+ purple, atranorine, alectoronic acid, and if pigmented rhodophyscin present.

Parmelia rimulosa is a typical South African species extremely common and confined largely to Natal and the Cape Province. The outstanding character is the cracking and flaking of the upper cortex, usually giving rise to extensive laminal pustulate-sorediate areas. The plants are quite thin and membranous. There seem to be no close relatives, although heavily sorediate specimens might be confused with *P. natalensis* Stein. & Zahlbr., a maculate species with distinct laminal soredia.

Additional specimens examined:

KENYA: Nyanza: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 11160 (L). UNION OF SOUTH AFRICA: Natal: South of Nkandhla, Nkandhla, *Almborn* 8069 (LD); along "Mountain Road," Cathedral Peak Area, Bergville, *Almborn* 9375 (LD); Mgnalsheni, Pohla, *Höeg*, Oct. 9, 1929 (TRH); Pietermaritzburg, Umgeni, *Höeg*, Sept. 29, 1929 (TRH); Impendhla, *Höeg*, Oct. 8, 1929 (TRH); Cape Province: Deepwells, Knysna, *Almborn* 10916 (LD), *Maas Geesteranus* 12163–12165, 12176 (L); Knysna, *Knobel*, Apr. 12, 1878 (BM); 6 mi. N. of Knysna, *Almborn* 2697 (LD); Grootvadersbosch, Swellendam, *Almborn* 2174 (LD); Tzitzikama Mtns., *Maas Geesteranus* 6624 pr. p. (L); Grahamstown, Albany, *Höeg*, December 1929 (TRH); Fern Kloof, Albany, *Almborn* 10734, 10739 (LD); Skeleton Stream, east slopes of Table Mountain, Wynberg, *Almborn* 11158, 11161 (LD); near upper Cableway Station, Table Mountain, *Almborn* 1731, 1733, 1892, 1897 (LD); Table Mountain, *Arnell* 1009 (LD); Jonkershoek, Stellenbosch, *Almborn* 1968, 11397, 11401 (LD).

73. Parmelia sancti-angelii Lynge, Ark. Bot. 13, no. 13:35. 1914.

Parmelia pseudohyporysalea Asahina *in* Kihara, Faun. Fl. Nepal Himalaya 54, *fig. 19*. 1955[?]. Type collection: Downside of Katunje Bazar, Nepal, *Kihara* (TNS, lectotype).

Type collection: Colonia Santo Angelo, near Cachoeira, Rio Grande do Sul, Brazil, *Malme s.n.* (S, holotype).

Thallus large, 10–20 cm. in diameter, loosely attached, light mineral gray, rather coriaceous; lobes rotund, 8–15 mm. wide, margins entire to broadly crenate, often ascending, ciliate, cilia 2–4 mm. long,

sorediate, soralia linear, sorediate lobes often becoming involuted; upper surface dull, continuous to finely cracked with age, rarely sorediate submarginally; medulla white, frequently orange red near the lower cortex; lower side black and sparsely rhizinate, light brown to mottled ivory and naked in a broad zone along the margins. Apothecia rare, more or less adnate, disc imperforate; hymenium 65 μ high; spores 7–10×13–18 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, pigmented medulla K+ purple, atranorine, gyrophoric acid, and (if pigmented) rhodophyscin present.

Parmelia sancti-angelii is a very common pantropical, corticolous or less commonly saxicolous species which, surprisingly, has only one synonym. Rhodophyscin occurs in about half of the specimens, including the type of *P. pseudohyporysalea* but not the type of *P. sancti-angelii*. *Parmelia rampoddensis* Nyl. is externally very similar but contains alectoronic acid (C−, KC+). *Parmelia permutata* Stirt. has a different K− pigment. These three species are closely related and chemical tests are sometimes necessary for certain identification.

Additional specimens examined:

MEXICO: Hidalgo: Huasco, near Pachuca, *Wood* s.n. (F); Veracruz: Mirador, *Sartorius* s.n. (M), *Purpus* 215 (US); 9 km. east of Jalapa, *Hale* 19433 (S, TNS, US), 21109 (US); northeast of Huatusco, *Hale* 19505 (DUKE, MSC, REN, US); Puebla: Xuchitl, *Arsène* 8236 (US); Michoacán: Morelia, *Arsène* 4460 (US). GUATEMALA: Hotel Tzanjuyu, Panajachel, *Gay* s.n. (F). COSTA RICA: Río Torres, *Pittier* 5051 (M); vicinity of Cartago, *Standley* 35468 (US).

HAITI: Citadel la Ferriore, *Thomas* 47 (MO, NY, US); between Petionville and Ft. Jacques, *Thomas* 36c (NY, US). DOMINICAN REPUBLIC: Guama, Santiago, *Wetmore* 3904 (MSC, US); vicinity of Constanza, La Vega, *Imshaug* 23318 (MSC, US), *Allard* 16543 (US); north side of Constanza, Cordillera Central, *Imshaug* 23721 (MSC, US). JAMAICA: Without locality, *Cummings* 38 (NY).

VENEZUELA: Miranda: Corrada del Guayado, *Dennis* 1565 (K); Los Chorros, *Dennis* 1524A (K); Mérida: El Valle, *Mägdefrau* 584 (M). COLOMBIA: Cauca: La Capilla, *Killip* 38483 (US). CHILE: Cautín: Pucon, *Gunckel* 18119 (MO). BRAZIL: Mato Grosso: Santa Anna da Chapada, *Sladen* 321 (BM); São Paulo: Piquete, *Robert* s.n. (BM); Santa Albertina, *Hemmendorff* s.n. (S). ARGENTINA: Misiones: San Ignacio, *Oniroga* K54 bis (S).

CONGO: Yangambi, Luweo Plateau, *Louis* 8155 p.p. (BR). KENYA: Rift Valley Prov.: Eastern Mau Forest Reserve, *Maas Geesteranus* 11313 p.p. (L); Nyanza Prov.: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 4956 p.p., 5532, 11160 (L). SOUTHERN RHODESIA: Zimbabwe, *Hõeg* s.n. (TRH). UNION OF SOUTH AFRICA: Natal: Boschfontein Forest, Lions River Distr., *Almborn* 8701 (LD). MADAGASCAR: Tananarive, *des Abbayes* s.n. (REN, US); 30 km. north of Ankazoba, *des Abbayes* s.n. (REN, US).

SIKKIM: Yokusam, *Hara et al.* s.n. (TNS, US). INDIA: Darjeeling, *Hara et al.* s.n. (TNS, US). THAILAND: Doi Chieng Dao, *Tsuyama* 12 (TNS, US). LAOS: Ban Phu Phao, *Tsuyama* 8 (TNS,US); Hase Plantations, *Tsuyama* 9

(TNS, US). SUMATRA: Raja Karohoogvlakte, *Lörzing* 7051 p.p. (BO); near Aer Batumbuk, *Groenhart* 8363 (BO); Pagar-alam, *Steup* 1024 (BO). CHINA: Kushan, near Foochow, Fukien, *Chung* F217 (FH, MICH). CELEBES: Rante Lemo, *Kjellberg* 33 (BO). JAVA: Mt. Gedeh, Tjibodas, *Groenhart* 8551 (BO).

74. Parmelia stuppea Tayl. London Journ. Bot. 6:175. 1847. PLATE 9

Parmelia perforata var. *claudelii* Harm. Bull. Soc. Sci. Nancy, n.s. 14: 223. 1896. Type collection: Docilles, France, *Claudel*, August 1890 (DUKE, holotype).

P. maxima Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:193. 1899. Type collection: Chimaleapan, near Lerma, Mexico, *Maury* 3318 (P, holotype).

P. claudelii (Harm.) Vain. Bot. Tidskr. 29:105. 1909.

P. trichotera Hue var. *claudelii* (Harm.) Du Rietz, Nyt Mag. Naturv. 62:77. 1924.

P. claudelii (Harm.) Tavares, Port. Acta Biol., ser. B, 1:152. 1945. Superfluous combination.

Type collection: Monterey, California, *Beechey* (FH-Tayl, holotype; BM, K, isotypes).

Thallus loosely attached to bark, 10–20 cm. in diameter, mineral gray; lobes rotund, 10–15 mm. wide, margins often ascending and suberect, sorediate, soralia terminal, linear, ciliate, cilia 2–3 mm. long; upper surface dull, continuous to cracked with age; lower side black and sparsely rhizinate, dark brown to brown and naked in a broad zone along the margins. Apothecia (known mostly from collections in western United States) very large, 10–30 mm. in diameter, stalked, disc perforate or rarely imperforate; hymenium 40–55 μ high; spores 6–9$\times$12–17 μ, episporium 1.0–1.5 μ thick; pycnidia present, conidia 4–6 μ long.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia stuppea is represented by a very fragmentary type specimen from California. Although badly decomposed, it has marginal soredia, a few cilia, and salacinic acid. It is thus similar to modern collections of a species that has been called *P. claudelii* in Europe or *P. trichotera* in North America. It is common in the mountains of North America, central America, and Europe, and more rarely in Africa and Asia (fig. 21). It is especially common on oak trees in dry forests. It intergrades with *P. cristifera* Tayl. in that a sterile specimen with sparse axial cilia could be identified as *P. stuppea* or as an abnormally ciliate form of *P. cristifera*. These two species in their typical forms are of course quite different in cilia and spore size. *Parmelia stuppea* may also be related to the Mexican species *P. eurysaca* Hue, which lacks soredia and has marginal laciniae.

Additional specimens examined:

U.S.: VERMONT: Scanlon Swamp, Leicester, *Dutton* 1620 (DUKE); MASSACHUSETTS: 5 mi. west of Blanchard, *Culberson* 4564 (DUKE); CONNECTICUT: 1 mi.

south of Colebrook, Litchfield Co., *Hale* 15406 (US); DELAWARE: Faulkland, *Commons* s.n. (PH); PENNSYLVANIA: 1 mi. east of Shunk, Sullivan Co., *Hale* 17442 (US); 2 mi. north of Red Rock, Luzerne Co., *Hale* 16160 (US); MARYLAND: 1 mi. east of Oldtown, Alleghany Co., *Hale* 14492 (US); WEST VIRGINIA: Clear Creek, Raleigh Co., *Hale* 11773 (US); Panther Knob, Pendleton Co., *Hale* 14302 (US); near Mace, Pocahontas Co., *Hale* 12482 (US); WISCONSIN: Park Falls, Price Co., *Culberson* 1818 (WIS); VIRGINIA: Mountain Lake Biological Station, Giles Co., *Hale* 18422 (US); Hawksbill Mountain, Madison Co., *Hale* 18884 (US); Hungry Mother State Park, Smyth Co., *Hale* 11931 (US); NORTH CAROLINA: 3 mi. north of Buckcreek Gap, McDowell Co., *Culberson* 4864 (DUKE); southeast of Rainbow Springs, Macon Co., *Anderson* 12911 (DUKE); near Waynesville, Haywood Co., *Standley* 5784 (US); TENNESSEE: Cliff Springs, Overton Co., *Phillips* 314 (US); CALIFORNIA: Pilarcitos Canyon, San Mateo Co., *Cain* 26381, 26384 (TRT, US); 2 mi. east of Pt. Reyes Station, Marin Co., *Koch* 393 (US); between Gilvey and Salinas, San Benito Co., *Herre* s.n. (US). MEXICO: VERACRUZ: 11 km. east of Las Vigas, *Hale* 21117 (US); PUEBLA: 69 km. east of Puebla, *Hale* 19327 (US); 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19611 (S, TNS, US); MEXICO: west of Río Frio, *Hale* 19281 (US); MICHOACÁN: 61 km. northwest of Zitácuaro, *Hale* 20838 (DUKE, MSC, REN, US); Cerro Azul, Morelia, *Arsène* 3996, 4016 (US); OAXACA: 53 km. northwest of Oaxaca, *Hale* 20814 (COLO, US); Cerro San Felipe, *Hale* 20694 (LISU, S, TNS, US); CHIAPAS: 14 km. west of San Cristóbal, *Hale* 20543 (MSC, REN, US). GUATEMALA: HUEHUETENANGO: Cumbre de la Sierra de los Cuchumatanes, *Standley* 81167 (MO). COSTA RICA: SAN JOSÉ: Santa Maria de Dota, *Standley* 43176 (US).

GERMANY: Munich, *Arnold, Lich. Exs.* 145 (MICH); Stuttgart, Wurttemberg, *Putzler* s.n. (LD). PORTUGAL: Serra de Sintra, Estremadura, *Tavares* 4783 (US); Serra do Bucaco, Beira Litoral, *Tavares* 23 (H).

UNION OF SOUTH AFRICA: NATAL: Eschowe, south of Solheim, *Höeg* s.n. (TRH). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH).

INDIA: Shembaganur, Madurai Distr., *Awasthi* 4345 (AWAS).

75. Parmelia subarnoldii des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:113. 1961.

Type collection: Forêt de Manjakatompo, Ankaratra, Centre Nord, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Thallus loosely adnate, 8–12 cm. across, mineral gray; lobes rotund, 7–10 mm. wide, margins often ascending, rather conspicuously ciliate, cilia 3–6 mm. long, sorediate, soralia, terminal, linear, sorediate lobes sinuous; upper surface plane, shiny, continuous; lower side black, sparsely rhizinate, brown, shiny, and naked in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine and protocetraric acid present.

Parmelia subarnoldii is a rare pantropical species. Externally it is very close to *P. sancti-angelii* Lynge but differs significantly in chemistry. It has no relation to *P. arnoldii* Du Rietz, a temperate species with distinct sublaminal soredia. Extreme ciliate forms of *P. dilatata* Vainio, such as occur in the West Indies, are virtually identical with *P. subarnoldii* except that the soredia are coarse and irregular and the cilia erratically produced.

Additional specimens examined:

MEXICO: Chiapas: 50 km. west of Tuxtla Gutiérrez, *Hale* 19904 (US), 19935 (DUKE, REN, S, US).
BRAZIL: São Paulo: Santa Albertina, *Hemmendorff*, July 3, 1898 (S).
MADAGASCAR: Manjakatompo, Centre Moyen, *Benoist* 1355 (LD).
NEW GUINEA: Mt. Arfak, Angi Gita Lake, *Kostermanns* 3012 (BO). JAVA: Tjinnivrang, *Ogata* 1001 (TNS).

76. Parmelia subcorallina Hale, Journ. Jap. Bot. 37:345, *fig.* 1. 1962.

P. proboscidea var. *corallina* Müll. Arg. Flora 67:616. 1884 (p.p.).

Type collection: Keitau, Taichu, Formosa, *Asahina* 3312 (TNS, holotype; US, isotype).

Thallus loosely adnate, 10–15 cm. in diameter, mineral gray; lobes rotund, 8–15 mm. wide, margins entire or subcrenate, in part isidiate-dissected, ciliate, cilia 1.5–3.0 mm. long; upper surface plane, continuous or reticulately cracked with age, faintly white-maculate, toward the margins moderately granulate-isidiate or isidiate, isidia cylindrical to inflated, simple or irregularly branched, 0.08–0.1 mm. in diameter, to 0.2 mm. high, often apically ciliate; lower side black and sparsely rhizinate, brown and naked in a broad zone along the margins. Apothecia not seen; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ reddish, P+ brick red, atranorine, protocetraric acid, and protolichesteric acid present.

Parmelia subcorallina is distinguished by the chemistry and by the usually granular isidia, in part close to those of *P. mellissii* Dodge. Since the publication of this species, two additional records from Java have been found. It is apparently endemic to Asia and the Madagascar region. The photograph in my original publication is enlarged two times.

Additional specimens examined:

JAVA: Tjibodas, *Meijer* 8928 (BO), *van Woerden* 2192 (BO).
MAURITIUS: *Robillard* s.n. (G). SÃO TOMÉ: *Moller* 70 pp. (H).

77. Parmelia subcrinita Nyl. Lich. Japon. 26. 1890.

Type collection: Hirosaki, Japan, *Almquist* (H, Nyl. herb. no. 35479, neotype).

Thallus loosely adnate, 10–20 cm. broad, mineral gray; lobes rotund, 6–12 mm. wide, margins crenate, ciliate, cilia 1–2 mm. long; upper surface plane dull to shiny, at times faintly white-maculate, becoming white-pruinose towards the tips, reticulately cracked in older parts, moderately isidiate, isidia cylindrical, simple to coralloid-branched, to 0.08 mm. in diameter and 0.3 mm. high, often ciliate apically; lower side jet black and rhizinate, dark brown, shiny, and naked in a broad zone at the margins. Apothecia rather rare, 3–6

mm. in diameter, disc imperforate; hymenium 65–75 μ high; spores 8–10×12–14 μ, episporium 1 μ thick; pycnidia rare, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

The typification of *P. subcrinita* has presented some problems. Nylander cited a collection by Almquist from Shimonoseki, Japan, in his original description. This collection could not be found at Helsinki or Stockholm. We have therefore selected as a neotype another specimen from Japan identified in Nylander's handwriting. *Parmelia subcrinita* is easily separated from *P. crinita* Ach. by chemical tests as well as by the smaller spore size, coarser cilia, and the more robust thallus. The upper cortex may be faintly maculate, as in the neotype, dull and opaque, or even pruinose. Reticulate fissuring with age may be pronounced. Another isidiate species with similar range and chemistry is *P. subtinctoria* Zahlbr., a species typically with distinct maculae and a uniformly pale lower side, or if darkened, short rhizines or papillae to the margin below.

Additional specimens examined:

U.S.: West Virginia: 3 mi. southwest of Jordan Run, Grant Co., *Hale* 14997 (US); Wisconsin: Flambeau River State Forest, Sawyer Co., *Hale* 2053 (WIS); Virginia: 6 mi. east of Wallaceton, Norfolk Co., *Ireland* 4177 (US); Little Stony Man Cliffs, Page Co., *Hale* 15177 (US); North Carolina: 10 mi. east of Fayetteville, Cumberland Co., *Hale* 17507 (US); 3 mi. north of Silver Valley, Davidson Co., *Culberson* 6446 (DUKE, US); 4 mi. east of Hayesville, Clay Co., *Culberson* 5299 (DUKE); South Carolina: Near Hodges, Greenwood Co., *Culberson* 7457 (DUKE, US); Santee State Park, Orangeburg Co., *Hale* 16494 (US); 12 mi. southwest of Andrews, Georgetown Co., *Hale* 16555 (US); Tennessee: Cliff Springs, Overton Co., *Phillips* s.n. (US); Georgia: Near McRae, Telfair Co., *Hale* 7573 (US); Toccoa, Stephens Co., *Culberson* 7346 (DUKE); Alabama: 15 mi. southeast of Birmingham, Shelby Co., *McCullough* 346 (US); Cheaha State Park, Cleburne Co., *Hale* 7086 (US); 2 mi. west of Cedar Cove, Tuscaloosa Co., *McCullough* 404 (US); Florida: 1 mi. east of Monticello, Jefferson Co., *Hale* 16461 (US); Sanford, Seminole Co., *Rapp* 495 (FLAS); Suwanee River State Park, Suwanee Co., *Hale* 17650 (US); Mississippi: Near Morton, Scott Co., *Hale* 7923 (US); near Durant, Holmes Co., *Hale* 7892 (US); near Tupelo, Lee Co., *Hale* 7830 (US); Arkansas: Near Hollis, Perry Co., *Hale* 3129 (US); Buffalo River Park, Marion Co., *Hale* 4483 (US); Oklahoma: Near Broken Bow, *Hale* 4925 (US); near Ludlow, Le Flore Co., *Hale* 5044 (US). MEXICO: Veracruz: 15 km. south of Catemaco, *Hale* 19850 (US); Mirador, *Liebmann* 117 (UPS); Michoacán: Rincón, Morelia, *Arsène* 4407 (US); Colima: Isla Socorro, *Herrera* 17 (MSC); Oaxaca: Cuyamecalco, *Conzatti* 3496 (US); Chiapas: 8 km. east of Teopisca, *Hale* 20335 (S, US); Hacienda, *Matuda* s.n. (MICH). HONDURAS: Morazán: Above El Zamorano, *Standley* 336 (MO).

DOMINICAN REPUBLIC: Along Río Inoa, at Inoa, *Imshaug* 23861 (MSC, US). JAMAICA: Clydesdale, *Plitt* sn.. (BPI, US). MARTINIQUE: Caravelle, *Degelius* s.n. (DEGEL).

VENEZUELA: Northeast of Puerto Ayacucho, Orinoco, *Mägdefrau* 115 (M, US). COLOMBIA: Norte de Santander: La Cabuya, *Cuatrecasas*

12057 (US). ECUADOR: Galapagos Islands: Santa Maria Island, *Taylor* 868 (MICH). BRAZIL: Bahia: Serra Chugue, *Luetzelburg* 408 (M); Minas Gerais: Caldas, *Regnell* s.n. (S).

AZORES: St. Jorge, *Persson* s.n. (UPS).

JAPAN: Nirayama, Prov. Idzu, *Asahina* 56105 (TNS, US), *Kurokawa* 58009 (TNS, US). JAVA: West Bantam, *Groenhart* 9740 (BO); Gegerbentang, *Neervoort* 1187 (BO). NEW CALEDONIA: Nepouis Valley, *Williams* 14 (BISH, US).

78. Parmelia sulphurata Nees & Flot. Linnaea 9:501. 1835.

Parmelia persulphurata Nyl. *in* Cromb. Journ. Linn. Soc. Lond. 16:219. 1877. Type collection: Bahia, Brazil, *Crombie* (BM, holotype).

P. brisbanensis Stirton, Trans. Proc. Roy. Soc. Victoria 17:69. 1881. Type collection: Brisbane, Queensland, Australia, *Bailey* 228 (BM, holotype; GLAM, isotype.)

Type collection: Cuba, *Wright* 72 (UPS, neotype; BM, FH, K, M, US, isotypes).

Thallus adnate to loosely attached to bark, 6–10 cm. in diameter, yellowish to turtle green; lobes rotund, 5–8 mm. wide, soon irregularly branched, margins entire to dissected, ciliate, cilia variable, 1–4 mm. long; upper surface plane, dull, reticulately cracked in older parts (with yellow medulla showing through), sparsely to densely isidiate, isidia cylindrical, simple to branched, 0.03–0.05 mm. in diameter, to 3 mm. high; medulla deep lemon yellow; lower side black and rhizinate at the center, naked and brown in a broad zone along the margins. Apothecia and pycnidia not seen.

Reactions: Thallus K+ more intensely yellow; medulla K−, C−, KC−, P−, atranorine and vulpinic acid present.

This species has been correctly identified by most lichenologists because of the brilliant lemon-yellow medulla. Nylander, however, consistently called it *P. persulphurata* Nyl. and identified specimens of *P. endosulphurea* (Hillm.) Hale as *P. sulphurata*. *Parmelia endosulphurea* has different yellow pigments and lacks cilia. The Pöppig type of *P. sulphurata*, destroyed at Berlin, had been seen earlier by Hillmann (1939), who was able to confirm that the current concept of the species is correct. I have therefore selected as a neotype a widely distributed exsiccate from the type locality. The species is very common in the Caribbean, though not nearly as common as *P. endosulphurea*, and occurs widely in other tropical areas (fig. 22).

Additional specimens examined:

U.S.: Florida: 5 mi. south of Silver Glenn Springs, Marion Co., *Hale* 17579 (US); Eldorado, Lake Co., *Underwood* 2313 (FH); Sanford, Seminole Co., *Rapp, Merr. Lich Exs.* 76 (US); Louisiana: Grand Bayou, *Langlois* 42 (US). MEXICO: Campeche: Tuxpeña, *Lundell* 1303 (F); Yucatán: Tizimin, *Swallen* 2538 (MICH). HONDURAS: Comayagua: Comayagua, *Standley* 5829 (F). PANAMA: Canal Zone: Barro Colorado Island, *Scholander* s.n. (US).

CUBA: Pinar del Río: Northwest of Hotel San Vicente, *Imshaug* 25235 (MSC); San Diego de los Baños, *Earle* 275 (FH). DOMINICAN REPUBLIC: Consuelo, *Taylor* 152 (FH); north of San José de los Matas, *Wetmore* 3878 (MSC); Piedra Blanca, La Vega, *Allard* 16856 (US).

FRENCH GUIANA: Belizon, River Combé, *Degelius* s.n. (DEGEL). SURINAM: Without locality, s.c. (G, M). VENEZUELA: Cerro Pavón, Río Atabapo, *Mägdefrau* 285 (M). PERU: Loreto: Santa María, *Allard* 22470 bis (US).

IVORY COAST: 5 km. north of Abidjan, *Santesson* 10325 (UPS); 6–7 km. north-northeast of Tai, cercle de Man, *Santesson* 10463b (UPS). CONGO: Luweo Plateau, Yangambi, *Louis* 8172 (BR). REPUBLIC OF CONGO: Subluali, Maiumbe, *Gossweiler* 8136 (BM).

SUMATRA: *Steup* s.n. (BO).

79. Parmelia wainii A. L. Smith, Journ. Linn. Soc. London, Bot. 46:85. 1922.

Parmelia proboscidea var. *ornatula* Zahlbr. Bull. Herb. Boiss., Ser. 2, 4:135. 1904. Type collection: Serra do Ouro Preto, Brazil, *Damazio* 1090 (W, holotype; G, isotype).

Type collection: Caraça, Minas Gerais, Brazil, *Vainio, Lich. Bras. Exs.* 400 (TUR, Vain. herb. no. 2410, lectotype; BM, FH, K, M, UPS, isotypes).

Thallus adnate to loosely attached to bark, 5–15 cm. in diameter, mineral gray; lobes rotund, 8–12 mm. wide, margins smooth or irregularly digitate-lobulate and crowded in older parts, ciliate, cilia 2–5 mm. long; upper surface plane, dull, continuous or becoming reticulately cracked with age, isidia and soredia lacking; medulla white, rarely turning orange red near the lower cortex; lower side black, sparsely rhizinate, dark brown and naked or mottled tan in a broad zone along the margins. Apothecia common, stipitate, to 10 mm. in diameter, exciple entire to short-dentate, ciliate, amphithecium rugose, white-maculate, disc imperforate; hymenium 75–90 μ high; spores 6–10$\times$17–22 μ, the episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, pigmented medulla K+ purple, atranorine, alectoronic acid, and (if pigmented) rhodophyscin present.

A. L. Smith was familiar with *P. proboscidea* Tayl., a synonym of *P. crinita* Ach., because of her work in British lichens. When she saw Vainio's erroneous determinations of nonisidiate South American plants as *P. proboscidea*, she proposed a new name, *P. wainii*, for his misidentified material. *Parmelia wainii* is characterized by large rugose ciliate apothecia and conspicuously ciliate lobes. *Parmelia subrugata* Krempl. differs in having large spores, shorter cilia, and more richly branched, laciniate lobes. *Parmelia argentina* Krempl. differs in having a white rim below and more or less distinct maculae. *Parmelia wainii* is not common but has a characteristic South American-South African distribution pattern.

Additional specimens examined:

BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 582b (TUR). NIGERIA: Basse, *Dusén, Almb. Lich. Afr.* 31 (H, LD, UPS, US). CONGO: Crete de Mvakala, *Devred* 1368 (BR). MOÇAMBIQUE: Lourenço Marques, *Junoa* 472 (PRE). UNION OF SOUTH AFRICA: Natal: Ngoma, *Höeg* s.n. (TRH).

Subsection *Ornaticolae* Gyel. (1932, p. 225)

Thallus loosely adnate to suberect, 5–30 cm. in diameter; lobes broad, 5–20 mm. wide, the margins ciliate; upper cortex distinctly maculate; lower side brown or black with a brown or white marginal zone.

Type species: *Parmelia perforata* (Jacq.) Ach.

This subsection may be divided into two series: *Subpallidae,* the thallus with a pale entirely rhizinate lower side, and *Ornaticolae,* with a black center.

Series *Subpallidae*, ser. nov.

Thallus subtus ex toto pallidus, breve rhizinosus usque ad marginem, ceterum ut in subsectione *Ornaticolae.*

Type species: *P. subsumpta* Nyl.

This series of only three species seems to be unrelated to any other group in subgenus *Amphigymnia.* The species are closely related and appear to present a sorediate-isidiate-NIS series with a parallel development of chemical strains.

80. Parmelia subcaperata Kremplh. Nat. For. Kjoeb. Vid. Medd. 1873: 10. 1873. Plate 12

Parmelia erubescens Stirton, Scot. Nat. 4:201. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype).

Parmelia recipienda Nyl. Flora 68:609. 1885. Type collection: Brazil, s.c. (H, Nyl. herb. no. 35212, holotype).

Parmelia imperforata Nyl. Acta Soc. Sci. Fenn. 26, no. 10:7. 1899. Type collection: Brazil, *Glaziou* 1839 (H, Nyl. herb. no. 35425, holotype).

Parmelia annae Lynge, Ark. Bot. 13, no. 13:88, *pl. 2, fig. 6.* 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2368B (S, lectotype).

P. ceracea Lynge, Ark. Bot. 13, no. 13:97. 1914. Type collection: Pilcomayo, Gran Chaco, Paraguay, *Malme,* Sept. 7, 1893 (S, lectotype).

Type collection: Lagoa Santa, Serra da Piedade, Brazil, *Warming* 297 (M, holotype).

Thallus loosely attached, 5–12 cm. in diameter, turning buff in the herbarium; lobes rotund, 7–15 mm. wide, margins crenate, ciliate, cilia 1.0–3.0 mm. long, often branched; upper surface plane, shiny, strongly white-maculate, becoming cracked with age; lower side uniformly pale tan or darkening toward the center, densely short rhizinate to the margins. Apothecia abundant, to 30 mm. in diameter, stalked, disc perforate; hymenium 55–65 μ high; spores 6–10$\times$12–19

μ, episporium 1.0–1.5 μ thick; pycnidia abundant, conidia 10–13 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia subcaperata is characterized by the strongly maculate upper cortex, short rhizinate pale lower side, and the lack of soredia or isidia. It has the same chemical variation as *P. subsumpta* Nyl., a sorediate counterpart, but the distribution is more restricted. The types of *P. recipienda*, *P. annae*, and *P. ceracea* contain cryptochlorophaeic and protolichesteric acids, while the remaining types listed above all contain salacinic acid. Except for a single collection in Australia, the species is known only from South America.

Additional specimens examined:

Salacinic acid present:

BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 737 (TUR, UPS); Retiro, Itatiaia, *Dusén, Lich. Austroamer.* 82, 86 (H, LD, MSC, S, US); Carangola, *Mexia* 4322 (MO, US); Lagoa Santa, *Warming* 313 (M); Serra dos Orgãnos, *Ainsworth & Gregory* 553 (BM); Rio de Janerio: Rio de Janeiro, *Glaziou* 1843, 2001 (M), *Malme* 372 (S), *Fry* s.n. (BM); São Paulo: Piquete, *Robert* s.n. (BM); Rio Grande do Sul: Pareci Nova, *Lima* 48 (MO).

Cryptochlorophaeic acid present:

BRAZIL: Minas Gerais: Caldas, *Henschen* s.n. (UPS); São Paulo: Piquete, *Robert* s.n. (BM). PARAGUAY: Asunción, *Malme* 1678 * * * (S); Pilcomayo, Gran Chaco, *Malme* s.n. (MO). ARGENTINA: Jujuy: Quinta, *Fries* 27 p.p. (S); Salta: Urundel, Orán, *Grassi* 594 (MO); Formosa: Las Lomitas, *Pierotti* 2896 (MO).

81. Parmelia subsumpta Nyl. Flora 52:117. 1869. Plate 12

Parmelia urceolata Eschw. var. *nuda* Müll. Arg. Flora 63:266. 1880. Type collection: Petropolis, Brazil, *Deventer* 33 (G, holotype).

P. hypotropa var. *imperialis* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:189. 1899. Type collection: Brazil, *S.M. Theresa Christina*, 1887 (P, holotype).

P. petropoliensis Zahlbr. Sitzungsber. Akad. Wiss. Wien Math. Naturw. 111:426. 1902. Type collection: Petropolis, Brazil, *Höhnel* 177 (W, holotype).

P. corrugis (Fr.) Müll. Arg. var. *imperialis* (Hue) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

P. leucoxantha Müll. Arg. f. *firma* Ceng.-Samb. Annali Bot. 22, no. 1:18. 1939. Type collection: Serra dos Orgãos, Rio de Janeiro, Brazil, *Casaretti* 2444 (RO, holotype).

Type collection: Minas Gerais, Brazil, *Glaziou* s.n. (H, Nyl. herb. no. 35451, holotype).

Thallus loosely adnate to bark, up to 15 cm. broad, rather coriaceous, mineral gray turning buff in the herbarium; lobes rotund, 10–12 mm. wide, margins often ascending, subcrenate, sorediate, soralia elongate,

in older specimens becoming crescent-shaped, sorediate lobes involute, ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, strongly white-maculate, reticulately cracked with age; lower side uniformly pale to dark brown, rarely blackening, densely short rhizinate to the margin or with a narrow papillate zone along the margins. Apothecia rare, 10–13 mm. in diameter, stalked, amphithecium rugose, white-maculate, sorediate, disc imperforate; hymenium 65–75 μ high; spores 7–10×12–15 μ, episporium 1.0–1.5 μ; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present; or medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present.

Parmelia subsumpta is a widespread corticolous species in tropical America and Africa. The distinguishing features are the strongly maculate upper cortex and short rhizinate, pale lower side. The soralia are linear and terminal but often enlarge and may become involute or even crescent-shaped, as in the holotype of *P. subsumpta*. The lower side may blacken somewhat so as to resemble *P. leucosemotheta* Hue, which has a broad naked zone below. There are at least two chemical strains in *P. subsumpta*. The most common by far (including all the types listed) contains salacinic acid, rarely with traces of usnic acid. The second strain with protolichesteric and cryptochlorophaeic acids occurs in Nebraska, Brazil, and Peru. Since there is similar chemical variation in other species in this series, we hesitate to recognize two separate species.

Additional specimens examined:

Salacinic acid present:

U.S.: GEORGIA: Vogel State Park, Union Co., *Hale* 7325 (US). MEXICO: PUEBLA: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19653 (US); OAXACA: 32 mi. northwest of Oaxaca, *Cain* 27566d (TRT, US); CHIAPAS: 14 km. west of San Cristóbal, *Hale* 20568 (TNS, US); south of Teopisca, *Hale* 20509 (DUKE, US); El Sumidero Canyon, Tuxtla Gutiérrez, *Hale* 21044 (US); 50 km. west of Tuxtla Gutiérrez, *Hale* 19957 (US). GUATEMALA: HUEHUETENANGO: Río Pucal, *Standley* 82404 (MO); BAJA VERAPAZ: Above Santa Rosa, *Standley* 91074 (MO). PANAMA: CHIRIQUÍ: Llano del Volcano, *Scholander* s.n. (MO, US).

VENEZUELA: Avila, *Vogl* s.n. (M). BRAZIL: MINAS GERAIS: Lagoa Santa, *Warming* 307 (M); SÃO PAULO: São Paulo, *Hoehne* s.n. (M); RIO GRANDE DO SUL: Near Cachoeira, Santo Angelo, *Malme* 908 (S). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

CONGO: Biano, *Smitz* 3884 (BR). KENYA: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 11120 (LD, L). UNION OF SOUTH AFRICA: TRANSVAAL: Northeast of Haenertsburg, *Kapp* 1773 (PRE); NATAL: Polela Forest, Polela, *Almborn* 9506 (LD); CAPE PROVINCE: 6 mi. from Knysna, *Almborn* 2618 (LD).

Cryptochlorophaeic and protolichesteric acids present:

U.S.: Nebraska: Sandhills, Nebraska National Forest, *Henzlik* s.n. (MSC). PERU: Cuzco: Urubamba, *Vargas* 7274 (MICH, US). BRAZIL: Santa Catarina: Rio dos Bugres, Caçador, *Reitz* 13215 (US).

82. Parmelia subtinctoria Zahlbr. Symb. Sin. 3:193. 1930. Plates 2, 12

Parmelia proboscidea var. *aspera* Müll. Arg. Flora 69:258. 1886. Type collection: Caracas, Venezuela, *Ernst* 71 (G, lectotype).

P. virens f. *isidiosa* Müll. Arg. Ann. Nat. Hofmus. Wien 7:303. 1892. Type collection: Toowoomba, Queensland, *Hartmann* 58 (G, holotype; W, isotype).

P. leucosemotheta Hue f. *isidiata* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:192. 1899. Type collection: Ohio, U.S.A., *Lesquereux* 262 (P, holotype).

P. velutina Zahlbr. Ann. Crypt. Exot. 1:206. 1928. Type collection: Mt. Tjibodas, Java, *van Overeem* 89 (W, holotype) [non P. *velutina* (Ach.) Wallr. Fl. Crypt. Germ. 3:552. 1831].

P. protovirens Gyel. Repert. Sp. Nov. Fedde 29:289. 1931. Based on *P. virens* f. *isidiosa* Müll. Arg.

P. haitiensis Hale, Bryol. 62:20, *fig. 2*. 1959. Type collection: Blue Mountains, Jamaica, *Orcutt* 2987 (US, holotype).

Type collection: Sanyingpan, north of Yunnanfu, Yunnan, China, *Handel-Mazzetti* 5645 (WU, holotype).

Thallus adnate to loosely attached, 5–10 cm. in diameter, mineral gray but soon turning buff in the herbarium; lobes rotund, 10–15 mm. wide, margins crenate, sparsely ciliate, cilia 1.0–1.5 mm. long; upper surface plane, shiny, distinctly white-maculate, irregularly cracked with age, moderately to densely isidiate, isidia cylindrical, simple to branched, 0.04–0.07 mm. in diameter, to 1.0 mm. high, rarely ciliate apically; lower side uniformly pale brown, rarely darkening at the center, densely short rhizinate to the margin or with a narrow naked or papillate zone along the margins. Apothecia rare, 5–8 mm. in diameter, amphithecium isidiate, disc imperforate; hymenium 40–60 μ high; spores 5–8×8–11 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C− KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or medulla K+ yellow turning red, P+ pale orange red, atranorine and salacinic acid sometimes mixed with protolichesteric acid.

Parmelia subtinctoria is a widespread pantropical species (fig. 24) usually found in herbaria under the names *P. crinita* Ach. or *P. subcrinita* Nyl. *Parmelia crinita* differs in lack of maculae, large spores, black lower side, and the presence of stictic acid. *Parmelia subcrinita* lacks distinct maculae and has a black lower side. The chemical variation presents an interesting pattern. All specimens from the Americas that have been tested (about 50) contain only

salacinic acid or cryptochlorophaeic acid and protolichesteric acid. Those from Asia, including the holotypes of *P. subtinctoria* and *P. velutina*, contain a mixture of salacinic, cryptochlorophaeic, and protolichesteric acids. *Parmelia haitiensis* (and *P. proboscidea* var. *aspera*) contains cryptochlorophaeic and protolichesteric acids and represents the type of the K−, KC+ strain. These variants can be considered as no more than chemical strains at this time.

Additional specimens examined:

Salacinic acid present (with or without protolichesteric):

U.S.: West Virginia: 2 mi. north of Brandywine, Pendleton Co., *Hale* 18543 (US); 3 mi. northeast of Alvon, Greenbrier Co., *Hale* 16649 (US); near Huttonsville, Randolph Co., *Hale* 12493 (US); Kentucky: Near Oil Valley, Wayne Co., *Hale* 13360 (US); near Forest Cottage, Cumberland Co., *Hale* 13723 (US); Pennyrile State Forest, Christian Co., *Hale* 13217 (US); Illinois: Cadiz, Hardin Co., *Hale* 13947 (US); Iowa: Fayette Co., *Fink* s.n. (US); Missouri: Near Radical, Stone Co., *Hale* 2549 (US); Aurora, Lawrence Co., *Hale* 2516 (US); Hartville, Wright Co., *Hale* 4290 (US); Virginia: Mile 102, Blue Ridge Parkway, Bedford Co., *Hale* 19176 (US); Signal Knob Overlook, Warren Co., *Hale* 14844 (US); near Bane, Giles Co., *Hale* 12754 (US); North Carolina: Near Bynum, Chatham Co., *Culberson, Vĕzda Lich. Sel. Exs.* 70 (H, LD, US); near Oxford, Granville Co., *Culberson* 6520 (DUKE, US); 11 mi. north of Burlington, Alamance Co., *Hale* 16364 (US); Tennessee: Cliff Springs, Overton Co., *Phillips* s.n. (US); Backbone Mountain Recreation Area, Johnson Co., *Hale* 18391a (US); Georgia: Near Cleveland, White Co., *Hale* 7457 (US); Alabama: Pell City, St. Clair Co., *Hale* 7235 (US); 15 mi. southwest of Rockford, Coosa Co., *McCullough* 1025 (US); Florida: Sanford, Seminole Co., *Rapp* s.n. (FLAS, US); Mississippi: Holly Springs, Marshall Co., *Hale* 7841 (US); Louisiana: Near Shreveport, Caddo Parish, *Hale* 5620 (US); Arkansas: 8 mi. south of Hollis, Perry Co., *Hale* 3095 (US); Crystal Springs, Garland Co., *Hale* 3050 (US); Danville, Yell Co., *Hale* 3734 (US); Black Springs, Montgomery Co., *Hale* 3896 (US); Oklahoma: Beaver Bend State Park, McCurtain Co., *Hale* 4929 (US); north of Sallisaw, Sequoyah Co., *Hale* 5030 (US); Texas: Near Milano, Milam Co., *Hale* 5471 (US); near Avinger, Cass Co., *Hale* 5265 (US); Kansas: Batesville, Woodson Co., *Hale* 4676 (US); near Coyville, Wilson Co., *Hale* 4728 (US); Arizona: Cave Creek, Chiricahua Mountains, Cochise Co., *Weber* 8787 (COLO, US). MEXICO: Hidalgo: Jacala, *Chase* 7431 (F, US); Veracruz: 15 km. south of Catemaco, *Hale* 19859 (US); Puebla: 3 km. west of Puebla-Veracruz state line, on highway 150, *Hale* 21043 (US); Mexico: North of Acambay, *Cain* 27593 (TRT, US); Michoacan: 61 km. northwest of Zitácuaro, *Hale* 20862 (MSC, US); Oaxaca: 132 km. northwest of Oaxaca on highway 190, *Hale* 20826 (DUKE, MSC, REN, S, TNS, US); Chiapas: El Sumidero, Tuxtla Gutiérrez, *Hale* 20013 (US), south of Teopisca, *Hale* 20503 (COLO, US). GUATEMALA: Ciudad Vieja, *Tejada* s.n. (FH, US). HONDURAS: Comayagua: Siguatepeque, *Standley* 6355 (F).

CUBA: Oriente: Slope of El Gato, Loma del Gato, *Imshaug* 24746, 24798 (MSC). HAITI: Eastern end of Montagne Noire, *Imshaug* 22529 (MSC).

PARAGUAY: Río Apa, Colonia Risso, *Malme* s.n. (S).

KENYA: Rift Valley Prov.: Cherangani, *Maas Geesteranus* 4711 (L); Nyanza Prov.: Londiani, Kisumu-Londiani, *Maas Geesteranus* 10935 (L); Tinderet Forest Reserve, *Maas Geesteranus* 11091 (LD, L). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH), *Sim* s.n. (BM). SWAZILAND:

Piggs Peak, *Almborn* 7902 (LD). UNION OF SOUTH AFRICA: TRANSVAAL: Punch Bowl Inn, north of Louis Trichardt, *Almborn* 6431 (LD, US); Houtbosch, Pietersburg, *Almborn* 6767 (LD); NATAL: Boschfontein Forest, Lions River Distr., *Almborn* 8712 (LD); Indumeni Forest, Cathedral Peak Area, *Almborn* 8874 (LD); Natal Table Mountain, *Almborn* 8577 (LD); Emmersdale, Estcourt, *Höeg* s.n. (TRH); CAPE PROVINCE: Matatiele, *Höeg* s.n. (TRH); northern part of Swellendam, *Almborn* 2155 (LD); Stormsrivier, Humansdorp, *Almborn* 4127 (LD, US); Keurboomsrivier, *Almborn* 2945 (LD); Parks Station, Knysna, *Arnell* 1500a (LD); 3 mi. east of Hermanus, Caledon, *Almborn* 5727 (LD).

INDIA: On way to Kasardeir, Almora Distr., *Awasthi* 3449 (AWAS). CHINA: Near Foochow, Kushan, Fukien, *Chung* F455 (FH). JAPAN: Honryu Temple, Nirayama, Prov. Idu, *Kurokawa* 58008 (TNS, US); Mt. Yatsugadake, Prov. Shinano, *Asahina* s.n. (TNS, US).

SUMATRA: Panprama Tabat Patah, *Groenhart* 9214 (BO). JAVA: Mt. Gedeh, *van Overeem* s.n. (MICH); Tjibodas, *van Woerden* 5493 (BO); Treanger, *Bakhuizen* 1518 (BO).

Cryptochlorophaeic and protolichesteric acids present (without salacinic acid):

U.S.: VIRGINIA: Brokenburg, Spotsylvania Co., *Hale* 15709 (US); NORTH CAROLINA: Darden, Martin Co., *Culberson* 6561 (DUKE); near Red Springs, Robeson Co., *Culberson* 7627 (DUKE); MISSISSIPPI: Near Aderman, Choctaw Co., *Hale* 7802a (US); ARKANSAS: Cove Lake, Logan Co., *Hale* 3452 (US); MEXICO: VERACRUZ: Northeast of Huatusco, *Hale* 19478 (US); PUEBLA: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19616 (US); CHIAPAS: 50 km. west of Tuxtla Gutiérrez, *Hale* 19921 (US).

HAITI: Summit of Montagne Noire, *Wetmore* 2722, (MSC), 2735 (MSC, US); near Boutillier, Morne Hospital, *Imshaug* 22514 (MSC). JAMAICA: Blue Mountains, *Orcutt* 2987 (US), *Imshaug* 14789 (MSC, US).

Additional records from the United States and the West Indies listed by Hale (1959a) as *P. haitiensis* are not repeated here.

Series *Ornaticolae*

Thallus black below in the center, the marginal rim commonly white or mottled, naked.

This is the most highly evolved group in subgenus *Amphigymnia*. Of the 23 species, only three, *P. hababiana*, *P. hypotropa*, and *P. subrugata*, may be considered pantropical. Sixteen of the species occur only in America or Africa or in both areas. There are two subgroups that may be recognized. One is characterized by a distinct white rim below along the margins and suberect lobes. It includes *P. abessinica*, *P. argentina*, *P. chiapensis*, *P. euneta*, *P. hababiana*, *P. hypotropa*, *P. melanothrix*, *P. paulensis*, *P. perforata*, *P. rigida*, *P. subrugata*, and *P. uruguensis*. Most of these species are centered in tropical America.

A second group has a dark marginal rim and more or less adnate lobes. It includes *P. cooperi*, *P. hanningtoniana*, *P. lobulascens*, *P. natalensis*, *P. nilgherrensis*, *P. pseudonilgherrensis*, *P. schimperi*, and *P. subcolorata*, all of which occur only in Africa or Asia.

The remaining species, *P. coralliformis*, *P. leucosemotheta*, and *P. reparata*, have very strong, almost effigurate maculae and occur chiefly in Mexico.

These three groups seem quite distinct, but relegating them to subseries would unnecessarily fragment the proposed subgeneric classification at this time.

83. Parmelia abessinica Kremplh. Linnaea 41: 140. 1877.

Parmelia glaucocarpa Müll. Arg. Flora 67: 615. 1884. Later homonym of *P. glacucocarpa* Ach. (=*Acarospora*). Type collection: Nossi-Bé, Madagascar, *Hildebrandt* 2150 (G, holotype; FH, FLAS, M, WU, isotypes).

P. abyssinica Nyl. Flora 68: 608. 1885. Superfluous name based on *P. abessinica* Krempth.

P. hildebrandtii var. *ciliata* Müll. Arg. Bot. Jahrb. Engler 20: 255. 1894. Type collection: Marangu Station, Kilimanjaro, Tanganyika, *Volkens* 275 (G, lectotype; BM, isotype).

P. abyssenica [sic] var. *glabrior* Stein. & Zahlbr. Bot. Jahrb. Engler 60: 526. 1926. Type collection: Between Mazumbai and Mzinga, West Usambara, *Brunnthaler* s.n. (WU, holotype).

P. glaucocarpoides Zahlbr. Cat. Lich. Univ. 6:167. 1929. Based on *P. glaucocarpa* Müll. Arg., non Ach.

P. nigeriensis Dodge, Ann. Mo. Bot. Gard. 46: 156. 1959. Type collection: Mongu Forest Reserve, Panshin, Plateau Province, Nigeria, *Keay & King* 37096 (K, holotype).

Type collection: Ethiopia, *Hildebrandt* s.n. (M, holotype).

Thallus adnate to loosely attached, often ascending, to 10 cm. in diameter, mineral gray, turning olivaceous in the herbarium; lobes rotund, 6–10 mm. wide, margins subcrenate to more or less lobulate with age, sparsely to moderately ciliate, cilia 0.5–2.0 mm. long; upper surface smooth, more or less distinctly white-maculate, rugulose and cracked with age; lower side black and sparsely rhizinate, brown to ivory or mottled and naked in a broad zone along the margins. Apothecia common, stipitate, 5–13 mm. in diameter, amphithecium rugose, white-maculate, exciple variable, entire or dentate and ciliate, disc perforate; hymenium 70–80 μ high; spores variable, 9–12×18–28 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present; or medulla KC+ red, atranorine, protolichesteric acid, and cryptochlorophaeic acid present.

Parmelia abessinica is the nonsorediate counterpart of *P. hababiana* Gyel. and has a similar geographical distribution and chemical variation, with two strains. The cryptochlorophaeic acid strain (including all types listed above except *P. glaucocarpa*) is less common but has a distribution similar to the protolichesteric acid strain. Spore size is intermediate and rather variable. The exciple is ciliate in less than half the specimens, and there is no apparent correlation of the

cilia with chemistry or distribution. *Parmelia abessinica* occurs on twigs and small branches of deciduous trees in open dry woods.

Additional specimens examined:

Cryptochlorophaeic and protolichesteric acids present:

MEXICO: Chiapas: El Zapotal, Tuxtla Gutiérrez, *Hale* 19990 (US). ETHIOPIA: North of Debra Marcos, Chokke Mountains, *Lythgoe* L46, L47 (K). CONGO: Southwest side of Lake Kivu, Mulungu, South Kivu, *Degelius* s.n. (DEGEL, US). ANGOLA: Bié: Chinguar, *Degelius* s.n. (DEGEL, US).

Protolichesteric acid alone present:

ETHIOPIA: Uoché, *Baldrati* s.n. (US). CONGO: Bangu, road to Thysville, *Compère* 1149 (BR, US); Mvakala Crater, *Devred* 1368 (BR); Lobito, *Quesyiere* 904 (BR); Lukuga Valley west of Albertville, *Höeg* s.n. (TRH). KENYA: Nyanza Prov.: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4956 (L, LD). UGANDA: Mt. Eglon, *Small* J19 p.p. (K). ANGOLA: Huila: Quilengues, *Degelius* s.n. (DEGEL, US). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH). UNION OF SOUTH AFRICA: Transvaal: Mambelane, *Mogg* 2110 (PRE).

84. Parmelia aldabrensis Dodge, Ann. Mo. Bot. Gard. 46: 160. 1959.

Type collection: Aldabra Islands, *Fox* 220 (K, holotype).

Thallus adnate to bark, 4–8 cm. in diameter, buff mineral gray in herbarium; lobes rotund to irregular, 5–10 mm. wide, margins smooth to crenate and short dentate-laciniate, ciliate, cilia 0.5–2.5 mm. long; upper surface smooth, shiny, more or less coarsely white-maculate; lower side brown to dark brown, rarely blackening, coarsely rhizinate, pale brown and naked along the margins. Apothecia 2–10 mm. in diameter, short-stalked, amphithecium maculate, disc perforate; hymenium 50–70 μ high; spores 5–7×13–18 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning to red, C−, KC−, P+ orange yellow, atranorine and norstictic acid (sometimes mixed with stictic acid) present.

This is a peculiar species of somewhat doubtful status, although the three collections seen are rather uniform. It is very near *P. perforata* (Jacq.) Ach. in several respects: The strong maculation, perforate apothecia, small spores, and the presence of norstictic acid. It differs from *P. perforata* in size, being much smaller and more adnate, and in having a uniformly brown or darkening lower side, in contrast to the jet black center and white rim so characteristic of *P. perforata*. I believe these apparently consistent differences justify the recognition of *P. aldabrensis*.

Additional specimens examined:

TANGANYIKA: Wadiboma, *Fischer* 703 (BM, G). MADAGASCAR: Fort Dauphin, Vallée du Moyen Mandrare, *Decary*, Aug. 1, 1926 (LD).

85. Parmeli argentina Kremplh. Flora 61:476. 1878. PLATE 15

Parmelia urceolata var. *cladonioides* Müll. Arg. Flora 63:266. 1880. Type collection: Petropolis, Brazil, *Deventer* 35 (G, holotype).

P. melanothrix (Mont.) Vain. var. *argentina* (Kremplh.) Müll. Arg. Hedwigia 30:228. 1891.

P. macrocarpoides Vain. f. *phyllophora* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:177. 1899. Type collection: Brazil, *S. M. Theresa Christina*, 1889 (P, holotype).

P. laongii Lynge, Ark. Bot. 13, no. 13:68, *pl. 1, fig. 3.* 1914. Type collection: Santa Anna da Chapada, Mato Grosso, Brazil, *Malme* 2392* (S, holotype).

P. melanothrix f. *microspora* Lynge, Ark. Bot. 13, no. 13:56. 1914. Type collection: Villa Morra, Asunción, Paraguay, *Malme* 1585C (S, lectotype).

P. subproboscidea Lynge, Ark. Bot. 13, no. 13:36. 1914. Type collection: Asunción, Paraguay, *Malme* 1678 (S, holotype).

P. subrugata var. *mexicana* Vain. Dansk Bot. Ark. 4, no. 11:5. 1926. Type collection: Consoquitla, Mexico, *Liebmann* 7562e (TUR, holotype).

Type collection: Argentina, *Lorentz & Hieronymus* (M, holotype; BM, H, S, W, isotypes).

Thallus to 10 cm. in diameter, loosely attached to suberect on bark, mineral gray, turning buff in the herbarium; lobes rotund, broad, 7–12 mm. wide, margins entire to crenate and dissected, ciliate, cilia 1.5–3.0 mm. long, K—, or K+ violet; upper surface plane, shiny, more or less distinctly white-maculate, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, sharply delimited from a buff to ivory, naked, rugose zone along the margins. Apothecia common, stalked, 5–10 mm. in diameter, exciple short-dentate and ciliate, amphithecium maculate, disc imperforate; hymenium 50–70 μ high; spores 6–12×11–22 μ, episporium 1.5–2.0 μ thick; pycnidia common, conidia 5–7 μ long.

Reactions: Thallus K+ yellow; medulla K—, C—, KC+ orange red, P—, atranorine and alectoronic acid present.

Parmelia argentina is characterized by distinct maculae, imperforate, often ciliate apothecia, and a distinct pale or white zone below at the margin. The cilia may react K+ violet, as in the type specimens of *P. laongii* and *P. subproboscidea*, but this reaction is variable and apparently of no taxonomic significance. My preliminary key to the group (Hale, 1960) illustrates the futility of separating species on cilia reaction or minor variation in spore size. *Parmelia argentina* could be confused with *P. rigida* Lynge and *P. chiapensis* Hale, both of which have perforate apothecia, with *P. subrugata* Kremplh., which has large spores, or even with *P. melanothrix* (Mont.) Vain., which has protolichesteric acid and large spores.

Additional specimens examined:

MEXICO: CHIAPAS: El Zapotal, near Tuxtla Gutiérrez, *Hale* 19991, 20005 (US); El Sumidero, near Tuxtla Gutiérrez, *Hale* 20061 (US). HONDURAS: COMAYAGUA: Vicinity of Comayagua, *Standley & Chacón* 5925 (F, US); EL PARAÍSO: Vicinity of Galeras, *Standley et al.* 1969 (F, US).

VENEZUELA: Lara: Barquisimeto, *Saer* 44 (US). BRAZIL: Minas Gerais: Sitio, *Vainio, Lich. Bras. Exs.* 973 (TUR); Mato Grosso: Corumbá, *Malme* s.n. (S); no locality, *Theresa Christina,* 1899 (P). PARAGUAY: Asunción, *Malme,* Aug. 27, 1893 (UPS); Pilcomayo, Gran Chaco, *Malme,* Sept. 3 and 7, 1893 (S). ARGENTINA: Salta: Río Pescado, Orán, *Digilio-Grassi* 382 (MO).

86. Parmelia chiapensis Hale, sp. nov. Plate 15

Thallus laxe adnatus, 8–15 cm. latus, albido-glaucescens, lobis rotundatis, 7–12 mm. latis, apicem versus margine integris, centrum versus denticulato-laciniatis, ciliatis, ciliis 1–2 mm. longis, superne nitidus, levissime albomaculatus, aetate irregulariter rimosus, strato corticeo superiore 16–20 μ crasso, strato gonidiali 22–28 μ crasso, medulla superiore alba, medulla inferiore pro parte crocea, toto 110–130 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger sparse rhizinosus, ambitu castaneus, albovariegatus vel albicans, late nudus. Apothecia numerosa, pedicellata, ad 12 mm. diametro, amphithecio revolutente, rugoso, valde albomaculato, disco late perforato; hymenium 70–80 μ altum; sporae 9–12×18–22 μ, episporio 1.5–2.0 μ crasso; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla alba K−, C−, KC+ rubescens, P−, medulla crocea K+ atropurpurea, atranorinum, acidum alectoronicum et rhodophyscin continens.

Type in the National Science Museum, Tokyo, collected at Monte Ovando, Chiapas, Mexico, Jan. 1, 1925, by Eizi Matuda (no. 105; isotype in US).

Parmelia chiapensis is superficially very close to *P. argentina* Kremplh., especially in lobation and habit, but has perforate apothecia and lacks a distinct white zone below. *Parmelia subrugata* Kremplh. has a larger thallus, imperforate apothecia, and large spores. This species is known from the Chiapas highlands in Mexico and adjacent Guatemala.

Additional specimens examined:

MEXICO: Chiapas: Mt. Ovando, *Matuda,* December 1937 (MICH) and 45 (TNS). GUATEMALA: Quezaltenango: South of San Martín, *Standley* 83659 (MO).

87. Parmelia cooperi Stein. & Zahlbr. Bot. Jahrb. Engler 60:528. 1926. Plate 13

Parmelia segreganda des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:112. 1961. Type collection: Ambohitantely forest, near Ankazobe, Madagascar, *H. des Abbayes, Lich. Mad. Bor. Sel. Exs.* 17 (REN, lectotype; H, M, UPS, US, isotypes).

Type collection: Kapprana, Kapland, Africa, *Cooper* 1813 (W, holotype).

Thallus large, to 15 cm. in diameter, loosely attached, light mineral gray; lobes rotund, broad, 10–15 mm. wide, margins sorediate, soralia linear, rarely becoming submarginal, sorediate lobes sinuous,

margins ciliate, cilia 1.5–3 mm. long; upper surface plane, more or less distinctly white-maculate, reticulately cracked with age; lower side black, sparsely rhizinate, pale brown and naked in a broad zone at the margins. Apothecia poorly developed, adnate, 1–2 mm. in diameter, disc imperforate; hymenium 90–95 μ high; spores 7–10$\times$18–20 μ, episporium 1–1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K—, C+ blood red, KC+ blood red; P—, atranorine and lecanoric acid present.

Parmelia cooperi is a distinctive east African lichen (fig. 25) with an unusual combination of characters, lecanoric acid and cilia. Except for the presence of cilia and imperforate apothecia, it is very close to *P. austrosinensis* and occupies similar habitats in the dry forests of Africa. Dr. des Abbayes kindly showed me an isotype of his *P. segreganda*, which at the time seemed unique to me. Later examination of the type of *P. cooperi*, however, led me to regard them as the same species, although the cilia of *P. segreganda* are exceptionally long.

Additional specimens examined:

CONGO: Ibanda, Kabare, *Spirlet*, s.n. (BR); Kalongi, Albert National Park, *de Witte* 10307 (BR, US). KENYA: Rift Valley Prov.: Eastern Mau Forest Reserve, Nakuru distr., *Maas Geesteranus* 11313 (L); Nyanza: Londiani, Kisumu-Londiani, *Maas Geesternaus* 10932 (L, LD). TANGANYIKA: Livingstone Mountains, Milo, *Rae*, 1935 (BM). UGANDA: Kizezi, Naiziru, *Dale* L48 (K). SOUTHERN RHODESIA: Zimbabwe, *Höeg*, Feb. 2, 1930 (TRH). UNION OF SOUTH AFRICA: Transvaal: Houtboschberg, *Nelson* 1056 (TRH); Cape Prov.: 6 mi. west of Heidelberg, *Höeg*, June 12, 1929 (TRH). MADAGASCAR: La Mondraka, *Benoist*, 1879 (LD); between Tananarive and Majunga, km. 133, *des Abbayes*, Aug. 20, 1956 (REN, US).

88. Parmelia coralliformis Hale, sp. nov. Plate 14

Thallus laxe adnatus, expansus, rigidulus, usque ad 10 cm. latus, viridi-glaucescens, lobis rotundatis, parum ramosis, margine integris vel sinuato-incisis, centrum versus isidiatis, isidiis dense coralliformibus ramosis (ut in *P. fasciculata* Vain.), usque ad 5 mm. altis, apicibus nonnullis sparse sorediatis fatiscentibus, margine ciliatis, ciliis numerosis, 1.0–1.5 mm. longis, superne laevigatus, nitidus, valde albomaculatus, cortice continuo vel demum fisso, strato corticeo superiore 17–19 μ crasso, strato gonidiali 20–22 μ crasso, medulla alba, 90–95 crassa, strato corticeo inferiore 17–19 μ crasso, inferne niger, rhizinosus, ambitu castaneus, anguste nudus. Apothecia ignota. Thallus K+ flavida; medulla K+ rubra, C—, KC—, P+ aurantiaca, atranorinum et acidum salacinicum continens.

Type in the U.S. National Herbarium, collected in mature pine forests, elev. 2340 m., 18 km. southeast of San Cristóbal, Chiapas, Mexico, Mar. 24, 1960, by M. E. Hale (no. 20287; isotypes in REN, S).

Parmelia coralliformis has the large fatiscent coralloid isidioid growths typical of *P. fasciculata* Vain. and *P. ramuscula* Hale. It differs significantly from these two species in having a shiny, distinctly maculate upper surface. The rhizines are often produced to the margin below in a manner reminiscent of *P. subcaperata* Kremplh. but the center is jet black. It is known only from the type locality in Mexico, and may be related to *P. leucosemotheta* Hue, a common Mexican species with similar maculae and chemistry but differing in having soredia.

89. Parmelia euneta Stirton, Scot. Nat. 4:298. 1877–78.

Type collection: Victoria, Africa, *Thomson* (BM, holotype; GLAM, isotype).

Thallus loosely adnate, corticolous, often expanded, 10–25 cm. in diameter, coriaceous, mineral gray; lobes rotund, margins entire to crenate, ciliate, cilia 2–4 mm. long; upper surface plane, shiny, faintly to distinctly white-maculate, reticulately cracked with age, isidia and soredia lacking; lower side black, sparsely rhizinate, brown to white or mottled in a broad zone at the margins. Apothecia stalked, 5–15 mm. in diameter, amphithecium strongly maculate, exciple usually ciliate, disc perforate; hymenium 60–80 μ high; spores 7–12×18–26 μ, episporium 1.5–2.5 μ thick; pycnidia numerous, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ blood red, P−, atranorine and gyrophoric acid present.

Parmelia euneta appears to be a pantropical species, although it is very rare outside of Africa. It is unique in the presence of maculae, gyrophoric acid, and stalked perforate apothecia. The thallus is usually quite large and rather coriaceous. The maculae vary considerably in distinctness but will always be distinct near the base of apothecia. The spores are uniformly intermediate in size. It has no close relatives with gyrophoric acid, but it does resemble externally *P. abessinica* Kremplh., a smaller more membranous species with a similar variation in maculae and with intermediate-sized spores.

Additional specimens examined:

HAITI: Kenscoff, *Thomas* 101 (MO, NY, US).

SIERRA LEONE: Falaba, *Small* 450 (K). ANGOLA: Mayumbe, *Gossweiler* 7181 (BM); Vila Salazar, Cuanza-Norte, *Degelius*, Mar. 6, 1960 (DEGEL, US). CONGO: Isalowe Reserve, Yangambi, *Louis* 8675 (BR, US). TANGANYIKA: Milo, Livingstone Mtns., *Rae*, 1935 (BM).

CEYLON: No locality, *Tiwary*, s.d. (BM).

90. Parmelia hababiana Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. PLATE 15

Parmelia abessinica var. *sorediosa* Müll. Arg. Flora 68:501. 1885. Nomenclatural basis of *P. hababiana*.

P. nilgherrensis f. *subciliaris* Vainio, Hedwigia 37:40. 1898. Type collection: Ruwenzori, Uganda, Africa, *Scott Elliott* 218 (TUR, holotype).

P. subciliaris (Vain.) Dodge, Ann. Mo. Bot. Gard. 40:377. 1953.

P. allenii Dodge, Ann. Mo. Bot. Gard. 46:150. 1959. Type collection: Lake Ngunga, Kenya, *Allen* 1783 (FH-Howe, holotype) (not 1837).
(?) *P. hendrickxii* Dodge, Ann. Mo. Bot. Gard. 46:124. 1959. Type collection: Kahusi, Congo, *Hendrickx* 4307 p.p. (EA, holotype).

Type collection: Near Hababab, Ethiopia, *Hildebrandt* 310 p.p. (G, lectotype).

Thallus loosely adnate to bark, 6–10 cm. in diameter, mineral gray; lobes rotund, 7–12 mm. wide, margins often subascending, crenate, sorediate, soralia linear or in part capitate and submarginal, sorediate lobes becoming revolute with age, ciliate, cilia rather sparse, 0.5–2 mm. long; upper surface dull to quite shiny, faintly to strongly white-maculate, especially near the base of apothecia, rarely becoming white-pruinose; lower side black and sparsely rhizinate at the center, brown to ivory or mottled and naked in a broad zone at the margins. Apothecia rare, 2–3 mm. in diameter, amphithecium sorediate, disc perforate; hymenium 60–70 μ high; spores 8–10×15–81 μ, episporium 1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present; or medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

The name *P. hababiana* was probably proposed by Gyelnik as a nomenclatorial exercise, since he did not see the the type of the variety forming the basis of the species or, as far as we know, identify any material belonging to this species. It now appears that *P. hababiana* is much more common than had been thought. It is common not only in the savannas of Africa but also in the dry upland oak forests of Central America and in Asia. The outstanding morphological characters are the marginal soralia, cilia, faint to distinct maculae, and white or mottled zone below near the margin. Superficially it appears very similar to the nonciliate species *P. praesorediosa* Nyl. or *P. austrosinensis* Zahlbr. More than half of the specimens, including all the type specimens listed above, contain protolichesteric and cryptochlorophaeic acids (KC+ red) and the remainder contain only protolichesteric acid (KC−). These two chemical variants have nearly identical distributions (figs. 26, 27), although the typical strain with cryptochlorophaeic acid is much more common throughout the geographic range. *Parmelia abessinica* Kremplh., which has similar chemical variation, is the nonsorediate counterpart of *P. hababiana*.

Additional specimens examined:

Cryptochlorophaeic and protolichesteric acids present:

U.S.: Arizona: Stewart Creek Campground, Chiricahua Mountains, Cochise Co., *Weber* S28021 (COLO, US). MEXICO: Oaxaca: 53 km. northwest of Oaxaca, *Hale* 20796 (US); 132 km. northwest of Oaxaca, *Hale* 20835 (US); Chiapas: Just south of Teopisca, *Hale* 20499 (S, US); 2 km. north of highway

190 on road to Puebla Nueva, *Hale* 20164 (US). GUATEMALA: JUTIAPA: Vicinity of Jutiapa, *Standley* 75949 (F, MO). HONDURAS: COMAYAGUA: Siguatepeque, *Yuncker* 6505 (MO). NICARAGUA: JINOTEGA: Cerro Sialci, *Standley* 10591 (F). COSTA RICA: La Palma, *Valerio* 13 (S).

ARGENTINA: Santiago del Estero, Dept. Bando, *Vega* 20960 (SI).

ANGOLA: BIÉ: Chinguar, *Degelius* s.n. (DEGEL). KENYA: RIFT VALLEY PROV.: Lake Nakuru, *Maas Geesteranus* 4631 (L), Eastern Mau Forest Reserve, Nakuru Distr., *Maas Geesteranus* 11378 (L); Cherangani, *Maas Geesteranus* 4708 (L); CENTRAL PROV.: Nairobi, *Maas Geesteranus* 4438 (L); NYANZA PROV.: Tinderet Forest Camp, Kisumu-Londiani Distr., *Maas Geesteranus* 4955 (L, LD, US). SOUTHERN RHODESIA: Zimbabwe, *Höeg* s.n. (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: Louis Trichardt, Hanglip Forest, *Almborn* 12011 (LD); NATAL: Emmersdale, Estcourt, *Höeg* s.n. (TRH); Creighton Station, *Höeg* s.n. (TRH). MADAGASCAR: Tananarive, *Bathie* s.n. (LD).

INDIA: Almora Distr.: Above village Naret, Askote, *Awasthi* 3297 p.p. (AWAS); Ranikhet, *Awasthi* 3548 (AWAS). CHINA: Schilungba, Yunnan, *Handel-Mazzetti* 255 (MICH).

Protolichesteric acid only present:

MEXICO: OAXACA: Cerro Zempoaltepetl, *Hallberg* 690 (MICH).

LIBERIA: WESTERN PROV.: Wohmen, Vonjama, *Baldwin* 12452 (US). ANGOLA: CUANZA-NORTE: Salazar, *Degelius* s.n. (DEGEL); BENGUELA: Between Benguela and Coporolo, *Degelius* s.n. (DEGEL). KENYA: RIFT VALLEY PROV.: Menengai, Nakuru Distr., *Maas Geesteranus* 10280 (L); NYANZA PROV.: Tinderet Forest Reserve, Kisumu-Londiani Distr., *Maas Geesteranus* 4949 (LD); CENTRAL PROV.: 4 mi. west of Nairobi, *Maas Geesteranus* 4394c (LD). SOUTHERN RHODESIA: Near Bulawayo, *Höeg*, s.n. (TRH). UNION OF SOUTH AFRICA: TRANSVAAL: 2 mi. north of Warmbad, Waterberg, *Almborn* 5889 p.p., 5896 (LD); NATAL: Boschfontein Forest, Lions River Distr., *Almborn* 8721, 8728 (LD); Natal Table Mountain, *Almborn* 8555 (LD); Weenen, *Höeg* s.n. (TRH); Emmersdale, Estcourt, *Höeg* s.n. (TRH); CAPE PROV.: Near Port Elizabeth, *Höeg* s.n. (TRH).

91. Parmelia hanningtoniana Müll. Arg. Flora 73:339. 1890. PLATE 2

Parmelia sinensis Hue f. *isidiata* Ceng. Samb. Nuov. Giorn. Bot. Ital. 40:283. 1933. Type collection: Limbolo, Angola, *Fenaroli* II (FI, holotype).

Type collection: South Africa, *Hannington* (G, holotype; K, isotype).

Thallus adnate to loosely attached, 5–8 cm. in diameter coriaceous, greenish mineral gray; lobes rotund, 15–20 mm. wide, margins crenate, ciliate, cilia 1.5–2.0 mm. long; upper surface distinctly white-maculate, plane to rugulose, isidia and soredia lacking; lower side black and sparcely rhizinate in the center, pale tan, rugose, and naked in a broad zone at the margins. Apothecia large, 4–10 mm. broad, stalked, amphithecium extremely wrinkled and lobulate, white-maculate, disc perforate; hymenium 50–60 μ high; spores 7–11×13–18 μ, episporium 1.5 μ thick, pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ red, P−, atranorine and gyrophoric acid present.

Parmelia hanningtoniana is apparently restricted to the savannas of west Africa. The unusual apothecia (cf. pl. 2) set it apart from all other Parmelias. They are large, stalked, and the amphithecium is coarsely sublobulate. In other respects it is close to *P. euneta* Stirt.

Additional specimens examined:

ANGOLA: Moxico: Between Luso and Cochipoque, *Degelius*, Feb. 16, 1960 (DEGEL, US); Koiembe, Quingenge-Benguela, *Damann, Tav. Lich. Lusit. Sel. Exs.* 168 (H, LD, US). CONGO: Biano, 26°3′ E., 10°16′ S., *Schmitz* 3884 (BR).

92. Parmelia hypotropa Nyl. Syn. Lich. 379. 1860.

Parmelia hypotropa var. *sorediata* Müll. Arg. Flora 60:77. 1877. Type collection: Near Dallas, Texas, *Boll* (G, holotype; US, isotype).

P. cetrata var. *hypotropoides* Nyl. ex Willey, Bot. Gaz. 21:203. 1896. Type collection: New Bedford, Massachusetts, *Willey* (US, holotype).

P. lividotessellata f. *ablephara* Hue, Nouv. Arch. Paris, ser. 4, 1:191. 1899. Type collection: Near Tonza, Algeria, Africa, *Maisonneuve*, November 1840 (P, holotype).

P. hypoleucina Stein. Oester. Bot. Zeitschr. 67:282. 1918. Type collection: Barro, Portugal, *Menyhart* 113 (WU, holotype).

P. trichotera var. *subincana* Mah. & Gil. Bull. Soc. Bot. Fr. 68:286. 1921 [1925]. Type collection: Forêt de Mamora, near Kenitra, Morocco, *Gillet* 105 bis (P, holotype).

P. subincana (Mah. & Gil.) Mah. & Gil. Bull. Soc. Bot. Fr. 72:862. 1925.

P. corrugis var. *sorediata* (Müll. Arg.) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

Parmotrema gattefossei Choisy, Bull. Soc. Bot. Fr. 78:458. 1931. Type collection: Forêt Mamora, Morocco, *Gattefossé* (LY, herb. no. 1698, holotype).

P. werneri Choisy, Bull. Soc. Bot. Fr. 78:457. 1931. Type collection: Oued Cherrat, Morocco, *Gattefossé* (LY, herb. no. 1753, lectotype).

Parmelia mueller-argoviensis Gyel. Repert. Sp. Nov. Fedde 29:288. 1931. Based on *P. hypotropa* var. *sorediata* Müll. Arg.

P. gattefossei (Choisy) Zahlbr. Cat. Lich. Univ. 8:559. 1932.

P. werneri (Choisy) Zahlbr. Cat. Lich. Univ. 8:569. 1932.

P. hypoleucina var. *subincana* (Mah. & Gil.) Werner, Bull. Soc. Sci. Nat. Maroc. 35:57. 1955.

Type collection: Comancharies, Texas [Mexico?], *Berlandier & Trécul* 2093 (P, holotype; H, isotype).

Thallus loosely adnate, 8–12 cm. in diameter, light mineral gray, sometimes turning pink below in the herbarium; lobes broad, ascending, 10–15 mm. wide, margins broadly crenate, ciliate, cilia 1–3 mm. long, sorediate, soralia linear, sorediate lobes sinuate; upper surface plane, shiny, strongly white-maculate, becoming rugose with age; lower side black and sparsely rhizinate in the center, outer margin white or rarely tan, rugulose, naked. Apothecia extremely rare, to 4 mm. in diameter, disc perforate; hymenium 40–50 μ high; spores 5–6×8–10 μ, episporium 1 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow or yellow

turning red, C−, KC−, P+ pale orange red, atranorine, norstictic and/or stictic acid present.

In his original description Nylander cites *Parmelia hypotropa* rather ambiguously as "*P. hypotropa" under *P. perforata*. It is possible to interpret *P. hypotropa* as having subspecific rank, but Nylander's brief notes also imply that it could be considered as a variety of *P. perforata*. I prefer to consider it as validly published at the species rank. In any event the first use of *Parmelia hypotropa* at a species rank (apparently Nylander in Flora 52: 291. 1869) still antedates any of the synonyms.

Parmelia hypotropa is easily recognized by the distinct maculae, marginal cilia and soredia, and the broad white marginal zone below. Apothecia are known only from a single collection. It is especially common in the southeastern United States (fig. 8) on the lower trunks of deciduous trees, and occurs also in southern California, in Mexico, in the Mediterranean region, and in one locality in Formosa. It is the sorediate counterpart of *P. perforata* (Jacq.) Ach., which has a similar but more southerly range in eastern United States (fig. 7) and is collected more frequently on the upper branches of deciduous trees.

All specimens from eastern North America and Mexico contain norstictic acid in abundance. Those from California and Europe (including the type specimens from Europe and Africa listed above) usually contain stictic acid, and norstictic acid cannot always be demonstrated with a G.A.o-T test, although a K_2CO_3 test is often successful. It is probable that the two acids always occur together but that our present chemical tests are not yet refined enough to detect them in mixtures.

Additional representative specimens examined:

U.S.: MASSACHUSETTS: New Bedford, Bristol Co., *Willey* s.n. (US); CONNECTICUT: 1 mi. south of Colebrook, Litchfield Co., *Hale* 15412 (US); NEW YORK: Near Sound, Suffolk Co., *Imshaug* 25770A (H); NEW JERSEY: Greenbank State Forest, Burlington Co., *Hale* 15331 (US); PENNSYLVANIA: 4 mi. northwest of Dingmans Ferry, Pike Co., *Hale* 16249 (US); DELAWARE: Laurel, Sussex Co., *Commons* s.n. (PH); MARYLAND: 2 mi. northwest of Bristol, Anne Arundel Co., *Hale* 14333 (US); WEST VIRGINIA: Near Pullman, Ritchie Co., *Hale* 10791 (US); 3 mi. northeast of Alvon, Greenbrier Co., *Hale* 18957; Glen Rogers, Wyoming Co., *Hale* 11643 (US); OHIO: Miami Whitewater Forest, Hamilton Co., *Taylor* 31 (US); Newstonville, Clermont Co., *Hale* 13225 (US); KENTUCKY: 4 mi. northeast of Whitly City, McCreary Co., *Hale* 13748 (US); 2 mi. east of Paducah, McCracken Co., *Hale* 13692 (US); INDIANA: Harrison County State Forest, Harrison Co., *Hale* 14038 (US); ILLINOIS: Grantsburg, Johnson Co., *Hale* 14013 (US); WISCONSIN: Near Dunnville, Dunn Co., *Culberson* 3725 (WIS); Wisconsin Dells, Juneau Co., *Thomson* 1825 (WIS); MISSOURI: Near Houston, Texas Co., *Hale* 4222 (US); VIRGINIA: Vint Hill Farms, Fauquier Co., *Cooke* (LD); Lee's Millpond, Isle of Wight Co., *Culberson* 7027 (DUKE); Prince William State Forest, Prince William Co., *Hale* 15223 (US); Millsboro Springs, Bath Co., *Hale* 12933 (US); NORTH

CAROLINA: 3 mi. southeast of Bertha, Currituck Co., *Culberson* 6968 (DUKE, US); 3 mi. north of Halifax, Halifax Co., *Hale* 16332 (US); 10 mi. south of Asheville, Buncombe Co., *Culberson* 7125 (DUKE); TENNESSEE: Sycamore, Cheatham Co., *Phillips* s.n. (US); Nashville, Davidson Co., *Gattinger* s.n. (fertile) (M); GEORGIA: Near Blue Ridge, Fannin Co., *Hale* 7321 (US); ALABAMA: De Soto State Park, De Kalb Co., *Hale* 7051 (US); FLORIDA: 3 mi. south of Sanford, Seminole Co., *Hale* 17679 (US); Eustis, Lake Co., *Nash* 1879 (US); MISSISSIPPI: 4 mi. south of Nettleton, Monroe Co., *Hubricht* B1533 (US); Holly Springs, Marshall Co., *Hale* 7850 (US); LOUISIANA: Plaquemines Parish, *Langlois* s.n. (PH, US); ARKANSAS: Near Briggsville, Yell Co., *Hale* 3747 (US); 0.5 mi. north of Francis, Boone Co., *Dodge et al.* s.n. (US); near Jasper, Newton Co., *Hale* 3081 (US); OKLAHOMA: Near Ardmore, Carter Co., *Hale* 4859 (US); TEXAS: Meridian, Bosque Co., *Hale* 5201 (US); Wisdom Ranch, Wilson Co., *Parks* 1098 (WIS); 20 mi. northwest of Fort Davis, Jeff Davis Co., *Parks* 1042 (WIS); Duffau, Erath Co., *Hale* 5496 (US); CALIFORNIA: San Diego, San Diego Co., *Palmer* 279 (US), *Alderson* 779 (US); Santa Catalina Island, *McGregor* 26 (US). MEXICO: TAMAULIPAS: South of Antigua Morelos, *Reeder* 1889 (US).

PORTUGAL: Near Magoito, Estremadura, *Tavares, Lich. Lusit. Sel. Exs.* 98 (H, US, WIS); near Azoia, Estremadura, *Tavares, Vezda Lich. Sel. Exs.* 68 (H, LD, US). ITALY: Pisa, Etruria, *Vivante, Gyel. Lichenoth.* 139 (H, LD); between Spezia and Pisa, *Hasselrot* s.n. (F).

MOROCCO: Near Rabat, *Gattefossé* s.n. (P); Oued Bouznika, Chaouia, *Gattefossé* s.n. (P).

FORMOSA: Keitau, *Asahina* 3411 (TNS, US).

93. Parmelia leucosemotheta Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:192. 1899.
PLATE 16

Type collection: Abrededores, San Luis Potosí, Mexico, *Maury* 7650 (P, holotype).

Thallus large, 10–20 cm. broad, loosely attached to bark, mineral gray; lobes rotund, 10–15 mm. wide, margins entire to dentate-laciniate with age, ciliate, cilia 1.5–2.5 mm. long, sorediate, soralia mostly on lateral margins, linear; upper surface shiny, strongly white-maculate, usually becoming conspicuously reticulately cracked with age; lower side black and sparsely rhizinate, dark brown to brown or mottled white in a broad zone along the margins. Apothecia rare, more or less adnate, to 6 mm. in diameter, amphithecium sorediate, disc imperforate or rarely perforate; hymenium 65–75 μ high; spores 7–10$\times$12–16 μ, episporium 1.0–1.5 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia leucosemotheta is characterized by strong maculation, marginal soredia, and a black lower side. It is very similar in many respects to *P. reparata* Stirt., which differs in being nonsorediate and in having perforate apothecia. It also closely resembles *P. subsumpta* Nyl., which differs principally in having a pale lower side with short dense rhizines and a narrow rhizinate or papillate zone at the margins. If specimens of *P. subsumpta* have an abnormally blackened lower

side, one must rely on the extent of papillae in the marginal zone to separate them from *P. leucosemotheta*, which typically has a broad, dark and shiny bare zone. These two species have similar distribution patterns, although *P. leucosemotheta* is much more common in Mexico.

Additional specimens examined:

MEXICO: Nuevo Leon: Monterrey, *Lacas* 521 (F); Hidalgo: La Placita, *Moore* 3900 (US); Veracruz: Northeast of Huatusco, *Hale* 19551 (COLO, DUKE, MSC, REN, S, TNS, US); 7 km. north of Fortín de las Flores, *Hale* 19709 (S, US), *Hale* 1690 (DUKE, US); 9 km. east of Jalapa, *Hale* 21233 (US); Puebla: 3 km. west of Puebla-Veracruz state line on highway 150, *Hale* 19614 (US); Michoacán: Morelia, *Arsène* 8238 (US); Oaxaca: Cerro del Machete, Pochutla Distr., *Reko* 6307a (F); Chiapas: 40 km. southeast of Comitan, *Hale* 20484 (US), 20483 (COLO, US); 14 km. west of San Cristóbal, *Hale* 20573 (LISU, US). GUATEMALA: Jalapa: Jalapa, *Standley* 76552 (MO). COSTA RICA: San José: Santa María de Dota, *Standley* 41727 (US); Cartago: North of Cartago, *Standley* 49616, 49635 (US).

HAITI: Summit of Montagne Noire, *Wetmore* 2730 (MSC).

BRAZIL: Minas Gerais: Caldas, *Mosén* 2313 (UPS), *Henschen* s.n. (UPS); São Paulo: Piquete, *Robert* s.n. (BM). ARGENTINA: Without locality, *Lorentz & Hieronymus* (M).

UNION OF SOUTH AFRICA: Boschfontein Forest, Lions River Distr., *Almborn* 8674 (LD).

94. Parmelia lobulascens Steiner, Verh. Zool. Bot. Gesell. Wien 53:234. 1903.

Type collection: Cameroons, *Bornmüller* (WU, holotype).

Thallus loosely attached, coriaceous, 5–10 cm. in diameter, mineral gray; lobes rotund, 8–14 mm. wide, margins entire, lobulate toward the center, central lobes often crowded, margins sorediate, soralia irregular to sublinear, ciliate, cilia rather sparse, 0.5–2.0 mm. long; upper surface shiny, moderately to strongly white-maculate, rugulose and cracked with age; lower side black and coarsely rhizinate, margins dark brown, naked, rugose. Apothecia and pycnidia unknown.

Reactions: Thallus K+ yellow; medulla K−, C+ rose, KC+ blood red, P−, atranorine and gyrophoric acid present.

The type of *P. lobulascens* is a very poor specimen. Laciniae or lobules are quite abundant and have irregularly sorediate margins, a fact overlooked by Steiner. Fortunately additional collections from Africa have clarified the range of variation in the species. The lobules may not be conspicuously developed and the soredia may be in elongate, more normal soralia. Maculae are always very distinct. It is extremely close to *P. pseudonilgherrensis* Asah., which contains alectoronic and α-collatolic acids and lacks lobules.

Additional specimens examined:

ETHIOPIA: North of Debra Marcos, Chokke Mtns., *Hiller* L85 (K); no locality, *Schimper*, s.d. (BM). KENYA: Nyanza: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 5532 (L).

95. Parmelia melanothrix (Mont.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:30. 1890.

Parmelia urceolata var. *melanothrix* Mont. Ann. Sci. Nat. Bot., ser. 2, 2:372. 1834.

Type collection: Brazil, *Gaudichaud* 89 bis (P, holotype).

Thallus 5–15 cm. in diameter, loosely attached to suberect on bark, mineral gray; lobes rotund, 6–12 mm. wide, margins crenate, short dentate-laciniate, especially toward the center, densely ciliate, cilia 2–3 mm. long; upper surface plane, shiny, white-maculate, isidia and soredia lacking; lower side black and rhizinate in the center, pale tan to white or mottled in a broad zone at the margins. Apothecia common, stalked, to 10 mm. in diameter, exciple minutely dentate or laciniate, ciliate, amphithecium rugose, maculate, disc imperforate; hymenium 80–100 μ high; spores 10–16×20–26 μ, episporium 2–3 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC−, P−, atranorine and protolichesteric acid present.

Parmelia melanothrix is one of the few tropical Parmelias that is usually correctly identified in herbaria. The salient taxonomic features are the large spores, K−, P− reaction, maculae, and cilia. The only species with which it might be confused is *P. argentina* Krempl h., which is KC+ red (alectoronic acid) and has intermediate-sized spores. *Parmelia melanothrix* has been commonly collected in southeastern Brazil; there is a disjunct locality in Réunion, in the Indian Ocean.

Additional specimens examined:

BRAZIL: Maranhao: São Bernardo, Serra de Cubatao, *Burchell* 3942 (K); Minas Gerais: Caldas, *Mosén* 2314, *Lich. Austro-Amer. Herb. Regnell.* 358 (BM, H, MSC, S, UPS, W); Sitio, *Vainio, Lich. Bras. Exs.* 950 (TUR, M, UPS); no locality, Warming 273 (M); Rio de Janeiro: Serra dos Orgãos, *Helmreichen*, s.d. (M), *Burchell* 2403 (K); Rio de Janeiro, *Glaziou* 1835 (M); São Paulo: Apiaí, *Puiggari*, s.d. (M); near Lapa, July 1901, *Schiffner* (M); Paraná: Fiarehy, September 1908, *Dusén* (M); Ypiranga, *Lüderwaldt, Zahlbr. Lich. Rar. Exs.* 222 (BM, BPI, MICH); Rio Grande do Sul: Elisenau, Württemberg, *Bornmüller* 796 (M).

RÉUNION ISLAND: Salazie, 1893, *Chauret* (P), 1889, *Rodriguez* (P).

96. Parmelia natalensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:515. 1926.

Type collection: Van Reenens Pass, Drackensberge, Black Mountains, Natal, Africa, *Brunnthaler* (W, holotype).

Thallus expanded, coriaceous, 8–15 cm. in diameter, mineral gray; lobes rotund, 9–15 mm. wide, margins entire, ciliate, cilia 1–3 mm. long, sometimes sorediate; upper surface plane, shiny, strongly white-maculate, becoming sorediate in a broad zone along the margins, soralia orbicular, soon coalescing into extensive sorediate masses; lower side black and sparsely rhizinate, brown and naked in a broad

zone along the margins. Apothecia rare, 3–8 mm. in diameter, very short-stalked, amphithecium sorediate, disc imperforate, often radially split; hymenium about 50 μ high; spores 10–13 $\times$ 18–22 μ, the episporium to 2 μ thick; pycnidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red or orange red, P−, atranorine and alectoronic acid present.

Parmelia natalensis, an African endemic, has a large coriaceous thallus with a broad submarginal zone of soralia. The maculae are usually very distinct. *Parmelia pseudonilgherrensis* Nyl., another maculate species with alectoronic acid, has strictly marginal soralia. *Parmelia rimulosa* Dodge, which occurs in South Africa, has a more membranous fragile thallus and extensive submarginal sorediate pustules.

Additional specimens examined:

CONGO: Volcan Karisimbi, Plaine de Lukumi, *Louis* 5411 (BR). KENYA: NYANZA: Tinderet Forest Reserve, Kisumu-Londiani, *Maas Geesteranus* 4956 (L, LD), 5017 (L, US), 5532 (L), 11100 (L); Londiani, Kisumu-Londiani, *Maas Geesteranus* 10933 (L, LD); RIFT VALLEY: Cherangani Mountains, Trans Nzoia Distr., *Maas Geesteranus* 4715 (L), 4829 (L, LD); Eastern Mau Forest Reserve, Nakuru Distr., *Maas Geesteranus* 11313 pr. p. (L). UNION OF SOUTH AFRICA: NATAL: Polela Forest, Polela, *Almborn* 9500 (LD).

97. Parmelia nilgherrensis Nyl. Flora 52:291. 1869.

Parmelia yunnana Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:186. 1899. Type collection: Lopin-chan, Yunnan, China, *Delavay*, July 31, 1888 (P, holotype).

P. siamensis Vain. Ann Soc. Zool. Bot. Fenn. 1, no. 3:37. 1921. Type collection: Doi Sutep, Thailand, *Hosseus* (TUR, holotype).

Type collection: Nilgherries Mountains, India, *Perrottet* (H, Nyl. herb. no. 35337, holotype).

Thallus loosely attached to bark, 8–15 cm. wide, mineral gray, turning buff in the herbarium; lobes rotund, 10–15 mm. wide, margins entire to crenate or dentate toward the center, ciliate, cilia 1–3 mm. long, rather coarse, often furcate; upper surface plane, shiny, strongly white-maculate, isidia and soredia lacking; lower side black and coarsely rhizinate, dark brown and naked in a broad zone at the margins. Apothecia large, numerous, 8–20 mm. in diameter, stalked, amphithecium strongly rugose and maculate, disc perforate; hymenium 100–130 μ high; spores 10–18 $\times$ 17–26 μ, episporium 2.0–2.5 μ; pycnidia abundant, conidia 14–16 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red or orange red, P−, atranorine, α-collatolic acid (predominantly), and alectoronic acid present; medulla, if pigmented, K+ purple, rhodophyscin present.

Parmelia nilgherrensis is a typical Asian species especially common in the foothills of the Himalayan Mountains (fig. 28). It is charac-

FIGURE 28.—Distribution of *Parmelia nilgherrensis* Nyl.

terized by strong maculae, perforate apothecia, and a dark lower side even at the margins. The predominant chemical is α-collatolic acid and the medulla does not fluoresce at all. The sorediate counterpart appears to be *P. pseudonilgherrensis* Asah.

Additional specimens examined:

SIKKIM: Lachen, *Hooker* 1994 (K). NEPAL: Lantang, Khola, *Polunin* M161 (BM); no locality, *Buchanan*, Feb. 3, 1803 (BM). INDIA: Wan, Gharwal Distr., *Pranavananda* A–119 (SESH, US); Ihageswar forests, en route to Ihagersen, *Sarma* A–114 (SESH, US); Ranikhet, *Senthna* 2 (US); Mussoorie, *Ali* 3 (BM), *Awasthi* 3815 (AWAS), *Mehra* 18 (MO); Mahasa, Simla, *Thomson* 1990 (K); Madras, *Gamble* 18048 (K); Jogeswar Ridge, Almora Distr., *Awasthi* 3505 (AWAS); Shola, near mile 9, Kodaikanal-Berijani Road, Madurai, *Foreau* 4238 (AWAS). CEYLON: Naini Jal, *Duvay*, May 1930 (BM). CHINA: YUNNAN: Eastern slopes of Likiang Snow Range, Likiang, *Rock* 11753 (US). THAILAND: Doi Sutep, *Hosseus* (TUR).

98. Parmelia paulensis Zahlbr. Denkschr. Akad. Wiss. Naturw. Wien 83:175, *pl. 1, fig. 6.* 1909.

Parmelia dolosa des Abbayes, Mem. Inst. Sci. Madagascar, ser. B, 10:115. 1961. Type collection: 30 km. northeast of Ankazobe, Forêt d'Ambohitantely, Centre Moyen, Madagascar, *des Abbayes* (REN, lectotype; US, isotype).

Type collection: Near Taipas, Mount Jaraguá, São Paulo, Brazil, *Schiffner* (W, holotype).

Thallus loosely attached, to 10 cm. broad, membranous, mineral gray; lobes rotund, to 15 mm. wide, subimbricate and dissected toward the center, margins and submarginal areas isidiate or sorediate-isidiate, densely ciliate, cilia 2–3 mm. long; upper surface smooth, dull to more or less distinctly white-maculate, becoming reticulately cracked with age; lower side black and sparsely rhizinate, dark to pale brown, ivory, or mottled and naked in a broad zone along the margins. Apothecia rare, 3–5 mm. in diameter, exciple short-dentate, ciliate, amphithecium rugose and maculate, disc imperforate;

hymenium 50–60 μ high; spores 13–15×26–28 μ, episporium 3 μ thick; pycnidia abundant, conidia to 10 μ long.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ faintly reddish or KC−, P−, atranorine, protolichesteric acid, and apparently an unknown substance present.

Parmelia paulensis has sorediate isidia very similar to those of *P. mellissii* Dodge, a pantropical species with alectoronic acid and intermediate spores. Unfortunately few specimens of *P. paulensis* have been available for study and the chemical constituents are uncertain. Protolichesteric acid is usually demonstrated but one syntype of *P. dolosa* (Forêt de Manjakatompo) appears to contain a fatty acid near caperatic acid. I was unable to prove gyrophoric acid reported by des Abbayes. The KC reaction is either negative or faintly reddish but no identifiable lichen substances have been demonstrated. *Parmelia paulensis* has an unusual Madagascar-Brazil distribution shared by *P. melanothrix* (Mont.) Vain., a related species.

Additional specimens examined:

MADAGASCAR: Forêt de Manjakatompo, Ankaratra, Centre Moyen, *des Abbayes*, July 30, 1956 (REN). RÉUNION: No locality, *Rodriguez*, 1890 (P).

99. Parmelia perforata (Jacq.) Ach. Meth. Lich. 217. 1803. PLATE 2

Lichen perforatus Jacq. Coll. Bot. III, 1:116, *pl. 3*. 1786.

Cetraria corrugis Fr. Syst. Orb. Veg. 1:283. 1825. Type collection: North America, *Schweinitz* (UPS, holotype).

Parmelia coriacea var. *perforata* (Jacq.) Eschw. *in* Mart. Fl. Bras. 1:206. 1833.

P. perforata var. *ciliata* Nyl. Syn. Lich. 377. 1860. Based on *Lichen perforatus* Jacq.

P. hypotropa f. *parmata* Nyl. *in* Cromb. Journ. Linn. Soc. London 17:568. 1880. Type collection: *pl. 20, fig. 44* in Dillenius, Hist. Musc. (OXF, holotype) (=*Parmelia perforata* (Jacq.) Ach.).

P. corrugis (Fr.) Müll. Arg. Flora 70:59. 1887. Based on *Cetraria corrugis* Fr.

P. hypotropoides Nyl. ex Willey, Bot. Gaz. 21:204. 1896. Type collection: New Bedford, Massachusetts, *Willey* (US, holotype).

P. corrugis f. *parmata* (Nyl. *in* Cromb.) Zahlbr. Cat. Lich. Univ. 6:236. 1929.

P. ciliata (Nyl.) Gyel. Report. Sp. Nov. Fedde 30:225. 1932. Based on *P. perforata* var. *ciliata* Nyl.

P. erecta Berry, Ann. Mo. Bot. Gard. 28:103. 1941. Type collection: Marble Falls, Newton Co., Arkansas, *Dodge, Berry*, and *Johnson* (MO, holotype).

Type collection: New England, *Tuckerman, Lich. Amer. Septentr. Exs.* 69 (UPS, neotype; isotypes in FH, L, M, MO).

Thallus loosely attached to suberect, corticolous, 8–12 cm. in diameter, light mineral gray or turning pinkish in the herbarium; lobes large, often monophyllous, 10–20 mm. wide, margins entire to lacerate or even laciniate, ciliate, cilia 2–4 mm. long; upper surface plane to

rugulose, shiny, strongly white-maculate, isidia and soredia lacking; lower side jet black and sparsely rhizinate at the center, pure white to ivory or rarely tan in a distinct broad zone along the margins. Apothecia numerous, stalked, 10–20 mm. in diameter, exciple rarely ciliate, amphithecium strongly rugose, maculate, disc perforate; hymenium 50–65 μ high; spores 7–9$\times$12–16 μ, episporium 1 μ; pycnidia numerous, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale yellow orange, atranorine and norstictic acid present.

A neotype is required for the typification of *P. perforata* since the holotype is probably destroyed, although represented by an excellent color plate. A logical choice of a neotype is the specimen in Tuckerman's exsiccate which is widely distributed in larger herbaria.

Parmelia perforata is a name which has in the past been applied to any large *Amphigymnia* species with perforate apothecia. Du Rietz (1924) did much to clear up the confusion and delimit the species more carefully. I had recognized the species as *P. hypotropoides* Nyl. (Hale, 1957) but later examination of Jacquin's plate left no doubt that *P. hypotropoides* is identical with *P. perforata*. The norstictic acid easily decomposes in improperly dried herbarium specimens and turns the white lower side pink or reddish. Other diagnostic characters are the distinct maculae, erect perforate apothecia, and the distinct white zone below (pl. 2). All of the specimens seen in the early part of this study were from eastern North America (see fig. 7), but several collections from Jamaica, Madagascar, and Ireland have extended the range considerably. In North America the species is most commonly found in the canopy of oak trees, whereas the sorediate counterpart, *P. hypotropa* Nyl., is more common on trunks near the base.

It is interesting to note that *Lichen cylindricus* L. (Sp. Pl. 1150. 1753), which antedates *Lichen perforatus*, is based primarily on "Lichenoides foliorum laciniis crinitis" Dill. Hist. Musc. 149, *pl. 20, fig. 42*. 1742. Dillenius' specimen (OXF) is typical *P. perforata* collected in Pennsylvania. Linnaeus cited a second syntype from Lapland; this specimen (LINN) is a small *Umbilicaria*. Linnaeus himself later realized that the American specimen did not fit his concept of *Lichen cylindricus* and put this name in the umbilicate series as a synonym of *L. proboscideus* L. without further explanation. All later authors have followed Linnaeus' concept without, however, realizing that *L. cylindricus* was based in large part on *Parmelia perforata*.

Additional specimens examined:

U.S.: Massachusetts: 1 mi. west of Tolland, Hampden Co., *Hale* 19092 (US); Connecticut: 1 mi. south of Colebrook, Litchfield Co., *Hale* s.n. (US);

NEW YORK: Chilson Lake, Essex Co., *Harris* s.n. (US); RHODE ISLAND: Bristol, *Howe, Lich. Nov. Angl.* 39 (M); DELAWARE: Laurel, Sussex Co., *Commons* s.n. (PH); OHIO: Near Cincinnati, Hamilton Co., *Lea* s.n. (PH); WISCONSIN: Fayette, Lafayette Co., *Cheney* 9220 (WIS); VIRGINIA: Skinquarter, Chesterfield Co., *Hale* 14574 (US); 5 mi. northeast of Wyllesburg, Charlotte Co., *Hale* 15814 (US); 3 mi. south of Laconia, Mecklenburg Co., *Hale* 15874 (US); NORTH CAROLINA: Shakelford Banks, Carteret Co., *Culberson* 6789 (DUKE, US); near Candler, Buncombe Co., *Green* s.n. (US); Florence, Pamlico Co., *Culberson* 5191 (DUKE); TENNESSEE: Between Del Rio and Newport, Cocke Co., *Sharp* TL5517 (WIS); Cross Roads, Overton Co., *Phillips* 336 (US); SOUTH CAROLINA: Northeast of Edgefield, Edgefield Co., *Standley* 92532 (F); FLORIDA: 5 mi. west of Clarksville, Calhoun Co., *Hale* 21865 (US); Gainesville, Alachua Co., *Nelson* s.n. (FLAS); 10 mi. east of Newport, Jefferson Co., *Hale* 21737 (US); 2 mi. west of Hosford, Liberty Co., *Hale* 21907 (US); Way Key, Levy Co., *Drouet* 11124 (F); LOUISIANA: Abita Springs, St. Tammany Parish, *Drouet* 9592a (F); southeast of New Iberia, Iberia Parish, *Drouet* 8937 (F); near Tunica, Feliciana Parish, *McFarland* 509 (WIS); TEXAS: Carrizo Sand Hills, Wilson Co., *Parks* 8 (US, WIS).

JAMAICA: *Greenwood* s.n. (K).

IRELAND: Without locality, *Taylor* s.n. (UPS).

MADAGASCAR: Near Ft. Dauphine, *Decary* s.n. (LD); near Berari, *Hildebrandt* s.n. (FH).

Additional records from the United States listed as "*Parmelia hypotropoides*" by Hale (1957) are not repeated here.

100. Parmelia pseudonilgherrensis Asahina, Journ. Jap. Bot. 29:370, *fig. 1.* 1954. PLATE 13

Parmelia nigrireagens Dodge, Ann. Mo. Bot. Gard. 46:145. 1959. Type collection: Kikandara, Toro Distr., Western Prov., Uganda, *Omaston* 3766c (K, holotype).

Type collection: Northern Korea, *Tsutani*, 1936 (TNS, holotype).

Thallus 5–10 cm. in diameter, loosely attached, mineral gray; lobes rotund, 8–15 mm. wide, margins sorediate, soralia linear, sorediate lobes sinuous; upper surface smooth, shiny, strongly white-maculate, submarginally sparsely sorediate; lower side black and moderately rhizinate, dark brown and naked in a broad zone along the margins. Apothecia unknown.

Reactions. Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, alectoronic and α-collatolic acids present.

Parmelia pseudonilgherrensis is apparently the sorediate phase of *P. nilgherrensis* Nyl. *Parmelia lobulascens* Stein. & Zahlbr. has similar maculae and soredia but contains gyrophoric acid. These species may prove to be chemical strains. Although only recently described from Korea, *P. pseudonilgherrensis* seems to be common on high mountains in Africa.

Additional specimens examined:

KENYA: Kinango, *Turner* 6388 p. p. (K); western slopes of Mount Kenya, elev. 3630 m., *Mearns* 1529 (US). UGANDA: Namwamba Valley, Ruwenzori, *Taylor* 3088 (BM); Mount Elgon, elev. 14,200 ft., *Dummer* 3397 (US); Kilimanjaro, *Hŏhnel,* 1890 (G).

NEPAL: Langtang Village, *Polunin* M179 (BM). KOREA: Kanchi-in, *Fujikawa*, Aug. 2, 1934 (TNS, US).

101. Parmelia reparata Stirton, Scot. Nat. 4: 201. 1877–78. PLATE 14
Parmelia virens Müll. Arg. Flora 69: 255. 1886. Type collection: Toowoomba, Queensland, Australia, *Hartmann* in 1882 (G, holotype).

Type collection: Cave Mountain, Brisbane, Australia, *Bailey* (BM, lectotype).

Thallus expanded, loosely adnate, up to 20 cm., coriaceous, mineral gray; lobes rotund, margins broadly crenate, ciliate, cilia abundant, 1.5–2.5 mm. long; upper surface plane, shiny, strongly effigurate white-maculate, becoming cracked with age, soredia and isidia lacking; lower side black and rhizinate, brown to mottled ivory and naked in a broad zone along the margins. Apothecia common, stalked, up to 20 mm. in diameter, amphithecium rugose, strongly white-maculate, disc perforate; hymenium 65–70 μ high; spores 6–7×13–16 μ, episporium 1 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ orange red, atranorine and salacinic acid present.

The type of *P. reparata* is unfortunately not in good condition. The lower side is dark and apparently sparsely rhizinate almost to the margins, exactly as in the type of *P. virens* Müll. Arg. The one collection from New Zealand and all collections from America cited below, however, have a broad distinct bare zone below. It is with some hesitation therefore that we identify the latter specimens with *P. reparata*, but the other morphological similarities, the strongly white-maculate upper cortex and perforate apothecia, are so great as to leave no other choice. The problem cannot be solved without field work or access to good recent collections from Australia. In Mexico, it seems that *P. reparata* is very closely related to and probably the nonsorediate counterpart of *P. leucosemotheta* Hue.

Additional specimens examined:

U.S.: ALABAMA: Mobile, Mobile Co., *Mohr* s.n. (US). MEXICO: VERACRUZ: 9 km. east of Jalapa, *Hale* 19406, 19394 (US); northeast of Huatusco, *Hale* 19529 (US); OAXACA: 32 mi. northwest of Oaxaca, *Cain* 27566a (TRT, US); CHIAPAS: El Sumidero, Tuxtla Gutiérrez, *Hale* 20078a (US).

AUSTRALIA: QUEENSLAND: Brisbane, *Bailey* s.n. (BM). NEW ZEALAND: North Island, *Gobby* s.n. (BM); Ashburton, *Allan* (BM).

102. Parmelia rigida Lynge, Ark. Bot. 13, no. 13:50, *pl. 2, fig. 2.* 1914.

Type collection: Piratiny, Rio Grande do Sul, Brazil, *Malme* 827B (S, holotype).

Thallus loosely attached, 6–12 cm. in diameter, mineral gray; lobes often suberect, rotund, 6–12 mm. wide, margins crenate to laciniate, ciliate, cilia 1–3 mm. long; upper surface shiny, minutely pitted, strongly white-maculate, rugose with age, soredia and isidia lacking; lower side black and sparsely rhizinate at the center, white

to ivory and naked in a broad zone along the margins. Apothecia common, pedicellate, to 20 mm. in diameter, exciple rarely ciliate, amphithecium rugose, white-maculate, disc perforate; hymenium 60–80 μ high; spores variable, 7–12×14–19 μ, episporium 1.0–1.5 μ thick; pycnidia common, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present.

Parmelia rigida is virtually indistinguishable from *P. perforata* without chemical tests. There are two main differences which may be cited to justify recognizing two distinct species. First, *P. rigida* occurs in extreme southern United States (fig. 29), most commonly

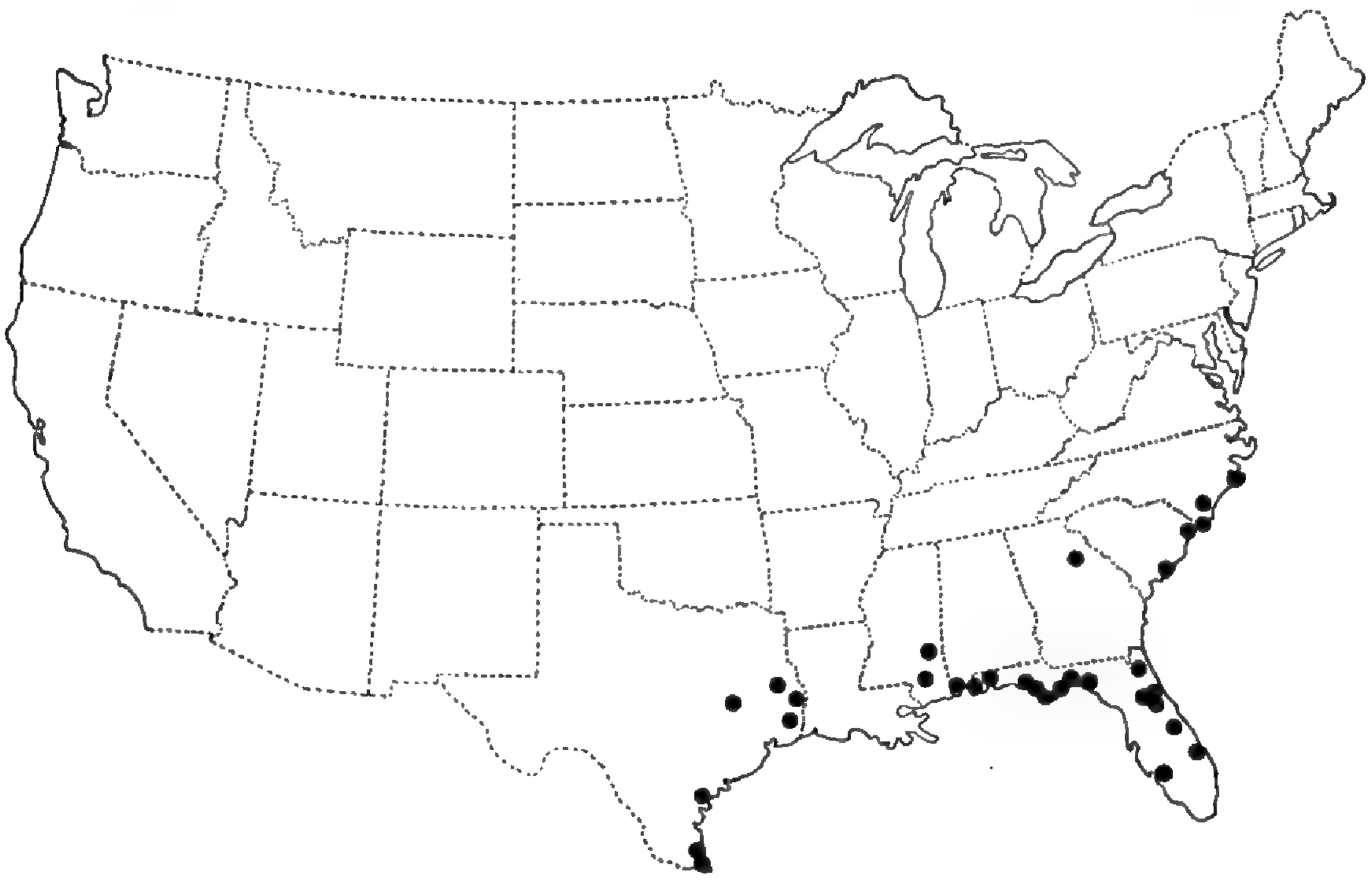


FIGURE 29.—Distribution of *Parmelia rigida* Lynge in the United States.

near shorelines, as well as in South America, whereas *P. perforata* has not been collected in South America and has a much broader distribution in North America (fig. 7). Second, the spores of *P. rigida* are more variable and on the whole slightly larger than those of *P. perforata*. Both species occupy similar habitats in the canopy of deciduous trees. Field studies in Florida have shown that the two species rarely grow mixed at the same locality.

Additional specimens examined:

U.S.: NORTH CAROLINA: Shakleford Banks, Carteret Co., *Culberson* 4919 (DUKE); Smith Island, Brunswick Co., *Culberson* 8005 (DUKE, US); SOUTH CAROLINA: Myrtle Beach, Horry Co., *Culberson* 9085 (DUKE); Isle of Palms, Charleston Co., *Culberson* 9049 (DUKE); GEORGIA: 10 mi. south of Greensboro, Greene Co., *Culberson* 6599 (DUKE, US); ALABAMA: Gulf Beach, Baldwin Co., *Hale* 7263 (US); near Wilmer, Mobile Co., *Hale* 7167 (US); FLORIDA: 5 mi.

south of Lokosee, Osceola Co., *Hale* 16975 (US); Tomoka State Forest, Volusia Co., *Hale* 17059 (US); Fort Myers, Lee Co., *Standley* 12898 (US); 5 mi. south of Clermont, Lake Co., *Hale* 16585 (US); Orange Park, Clay Co., *Hale* 17740 (US); 5 mi. south of Panacea, Wakulla Co., *Hale* 21918 (US); 10 mi. east of Newport, Jefferson Co., *Hale* 21710 (US); Eastpoint, Franklin Co., *Hale* 21692 (US); St. Joe Beach, Gulf Co., *Hale* 21847 (US); east of Pensacola, Escambia Co., *Hale* 7997 (US); 2 mi. north of Jonathan Dickinson State Park, Martin Co., *Imshaug* 23975 (MSC); Sanford, Seminole Co., *Rapp* s.n. (FLAS); MISSISSIPPI: Near Hattiesburg, Forrest Co., *Hale* 7989 (US); 9 mi. south of Montrose, Jasper Co., *McDaniel* L–40 (US); TEXAS: Saratoga, Hardin Co., *Fisher* 50007 (DUKE); Barreda, Cameron Co., *Runyon* 1587 (MSC); Yturria Ranch, Willacy Co., *Runyon* 3821 (MSC); west of San Augustine, San Augustine Co., *Hale* 5234 (US); Pineland, Sabine Co., *Hale* 5159 (US); Corpus Christi, Nueces Co., *Palmer* 11212 (US); east of Franklin, Robertson Co., *Walker* 45 (US).

BRAZIL: RIO GRANDE DO SUL: Piratiny, *Malme* 827* (S). URUGUAY: Yazuarg, Dept. Tacuarembó, *Rosengurtt* 2861 (US). ARGENTINA: JUJUY: Near Quinta, *Fries* 27 (S).

103. Parmelia schimperi Müll. Arg. Hedwigia 31:276. 1892.

Type collection: Near Debra, Ethiopia, *Schimper* 13 (G, lectotype; H, UPS, isotypes).

Thallus 10–15 cm. in diameter, loosely adnate to bark, mineral gray; lobes rotund, 10–12 mm. wide, margins entire, sparsely ciliate, cilia 0.5–1.0 mm. long; upper surface plane, strongly white-maculate; lower side black and moderately rhizinate, brown and naked in a broad zone at the margins. Apothecia to 10 mm. in diameter, amphithecium rugose, maculate, disc usually perforate; hymenium 65–70 μ high; spores 10–12×17–22 μ, episporium 1.0–1.5 μ thick.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine, cryptochlorophaeic acid, and protolichesteric acid present.

This distinctive species is still known only from several collections of the lectotype by Schimper. Outside of the unusual chemistry, it is distinguished by the strongly maculate cortex and the black lower side. In the absence of more material, it is difficult to decide what relation it might have to other species with cryptochlorophaeic acid such as *P. abessinica* Kremplh. Additional syntypes cited by Müller (Geraz, *Schimper* 1396 and Mount Kubbi near Adoa) were not found at Geneva and their identity is unknown.

104. Parmelia subcolorata Hale, sp. nov.

Thallus late expansus, laxe adnatus, rigidus, 10–15 cm. latus, lobis rotundatis, usque ad 15 mm. latis, margine integris, ciliatis, ciliis 1.0–2.5 mm. longis, superne nitidus, plus minusve valde albomaculatus, strato corticeo superiore 14–18 μ crasso, strato gonidiali 13–16 μ crasso, medulla aurantiaco-flavida pro maxima parte, partim alba, 100–135 μ crassa, strato corticeo inferiore 12–14 μ crasso, subtus niger, sparse rhizinosus, ambitu castaneus vel albovariegatus, late nudus. Apothecia usque ad 15 mm. lata, pedicellata, amphithecio

rugoso, albomaculato, disco imperforato; hymenium 50–60 μ altum; sporae 8–10×13–16 μ, episporio 1.0–1.5 μ crasso; pycnidia numerosa, conidiis non visis. Thallus K+ flavescens; medulla K+, C+, KC+ intensius lutea, P−, atranorinum, pigmentum K− ignotum continens.

Type in the Rijksherbarium, Leiden, collected in Tinderet Forest Reserve, Kisumu-Londiani, Nyanza, Kenya, Aug. 1, 1949, by R. A. Maas Geesteranus (no. 5359; isotype in US).

Parmelia subcolorata is a large conspicuous lichen known from only two localities in Africa. It differs significantly from similarly pigmented species (*P. myelochroa* Hale, *P. araucariarum* Zahlbr., etc.) in having distinct maculae, perforate apothecia, and long coarse cilia.

CONGO: Southwest side of Lake Kivu, Nulungu, *Degelius*, Mar. 19, 1960 (DEGEL).

105. Parmelia subrugata Krempl h. Verh. Zool. Bot. Gesell. Wien 18:320. 1868.

PLATE 16

Parmelia latissima f. *subrugata* Nyl. *in* Fourn. Mex. Pl. 1:3. 1872. Type collection: Brazil (H, holotype).

Parmelia cyathina Stirton, Scot. Nat. 4:252. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* 3 (GLAM, holotype).

Parmelia sinensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:187. 1899. Type collection: Near Yent-ze-Hay, Yunnan, *Delavay*, Aug. 8, 1888 (P, lectotype).

P. subrugata f. *integra* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:204. 1899. Type collection: Brazil, *S. M. Theresa Christina* (P, holotype).

P. subrugata f. *arcuata* Lynge, Ark. Bot. 13, no. 13:48. 1914. Type collection: Porto Alegre, Rio Grande do Sul, Brazil, *Malme* 440 (S, holotype).

P. amaniensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:526. 1926. Type collection: Amani, East Usambara, *Brunnthaler* s.n. (W, holotype).

Type collection: Organ Mountains, Minas Gerais, Brazil, *Helmreichen* s.n. (M, holotype).

Thallus loosely attached, corticolous, 7–15 cm. broad, mineral gray, turning buff in the herbarium; lobes rotund, 7–15 mm. wide, often soon crowded, convoluted, and obscured by lobules, margins crenate to dissected-laciniate, laciniae usually becoming canaliculate, suberect, moderately ciliate, cilia 1–3 mm. long; upper surface plane to rugulose, shiny, opaque or very faintly white-maculate, distinctly maculate at the base of apothecia; medulla white, turning orange red frequently near the lower cortex; lower side black and sparsely rhizinate at the center, brown to ivory or mottled in a broad zone at the margins. Apothecia common, stalked, to 12 mm. in diameter, exciple often short dentate-laciniate, ciliate, amphithecium heavily rugose and white-maculate, disc imperforate; hymenium 100–140 μ high; spores 12–18× 26–34 μ, episporium 3–4 μ thick; pycnidia abundant, conidia not seen.

Reactions: Thallus K+ yellow; medulla K−, C−, KC+ red, P−, atranorine and alectoronic acid present; medulla often pigmented, K+ purple, rhodophyscin present.

Des Abbayes (1962) was the first to place *P. sinensis* in synonymy under *P. subrugata*. These two species at first seem only distantly related. Typical *P. subrugata* has short laciniate, suberect lobes, rather distinct maculae, and a distinct pale zone below. *Parmelia sinensis*, known only from type collections, has more coriaceous lobes, less evident maculae, and darker zone below. However, both have alectoronic acid, large spores, and imperforate apothecia and must be considered as members of a single variable population. By applying these same criteria, we must also put *P. cyathina* Stirt., a coriaceous, strongly maculate species, and *P. amaniensis* Stein. & Zahlbr., a faintly maculate species, into synonymy. The amount of variation in *P. subugrata* is distressing, but separation of the plants seems to be artificial and unworkable.

Additional specimens examined:

MEXICO: Puebla: 5 km. west of Puebla-Veracruz State line on highway 150, *Hale* 19640 (DUKE, S, TNS, US); Chiapas: El Suspiro, 10 km. N. of Berriozábal, *Hale* 20207 (US). GUATEMALA: Guatemala: Volcan de Pacaya, *Standley* 58511 (MO).

HAITI: Summit of Montagne Noire, near Kenscoff, *Wetmore* 2747 (MSC).

BRAZIL: Minas Gerais: Caldas, *Regnell*, s.d. (S); Sitio, *Vain. Lich. Bras. Exs.* 994 (M, UPS); no locality, *Burchell* 1105:28 (K); Rio de Janeiro: Serra dos Orgãos, *Ainsworth & Gregory* 523 (BM). ARGENTINA: No locality, *Lorentz & Hieronymus*, 1872–74 (M).

MOÇAMBIQUE: Massangulo, *Sandrone* s.n. (F). UNION OF SOUTH AFRICA: Cape Prov.: Woodbury, Alexandria, *Hõeg*, July 20, 1929 (TRH); East London, *Höeg*, Dec. 20, 1929 (TRH).

CHINA: Yunnan: Sanyingpan, Yunnan-fu, *Handel-Mazzetti* 640 (W); Mekong-Salween, *Gebauer* s.n. (W).

AUSTRALIA: Queensland, *Bailey*, 1899 (BM).

106. Parmelia uruguensis Kremplh. Flora 61:461. 1878.

Parmelia dusenii Zahlbr. Ann. Mycol. 6:133. 1908. Type collection: Carmen de Patagones, Patagonia, Argentina, *Dusén* 158 (W, holotype; S, isotype).

P. hieronymi Lynge, Nyt Mag. Naturv. 62:88. 1925. Type collection: Abrededores, Pan de Azucar, Argentina, *Hieronymus* 34 (W, holotype).

P. perforata var. *ciliata* Ceng.-Samb. Contr. Sci. Miss. Sales. Don Bosco No. 6:45. 1930. Type collection: General Acha, Pampa, Patagonia, Argentina, *Macchi*, Apr. 25, 1910 (RO, holotype) [non *P. perforata* var. *ciliata* Nyl.].

Type collection: Córdova and Conceptión, Argentina, *Lorentz & Hieronymus* (M, holotype; isotypes in G, TUR).

Thallus loosely attached to twigs, 5–8 cm. broad, olivaceous in the herbarium; lobes rotund, often suberect, 8–15 mm. wide, margins crenate, short ciliate, cilia about 1 mm. long; upper surface plane, shiny, heavily white-maculate, reticulately cracked with age; lower side brown or blackening and short rhizinate at the center, white to

pale brown, rugose, short woolly rhizinate to the margins. Apothecia common, substipitate, to 10 mm. in diameter, exciple ciliate, disc perforate; hymenium 40–55 μ high; spores 5–7×9–13 μ, episporium 1 μ thick; pycnidia present, conidia not seen.

Reactions: Thallus K+ yellow; medulla K+ yellow turning red, C−, KC−, P+ pale orange red, atranorine and salacinic acid present.

Parmelia uruguensis differs rather significantly from other members of series *Ornaticolae*. It is, for example, the only species with salacinic acid. It has peculiar fine, short rhizines to the margin, much as in *P. subcaperata* Kremplh. The stalked perforate apothecia, pale margin below, suberect lobes, and maculae, however, place it nearer to species in series *Ornaticolae* than to any in series *Subpallidae*. It is apparently endemic to Argentina.

Additional specimen examined:

ARGENTINA: Buenos Aires: Tandil, *Yussen* 20948 (SI).

Nomina Inquirenda

The following names are untypifiable because the type specimens are presumed lost, unavailable, or too fragmentary for study.

Omphalodium mazoense Dodge, Ann. Mo. Bot. Gard. 46:192. 1959. Type collection: Mazoe, Southern Rhodesia, *Eyles* 420 (K, holotype).

The type collection is too fragmentary for study. It is probably a *Parmelia* species in subsection *Ornaticolae*, series *Ornaticolae*, and may contain alectoronic acid.

Parmelia adspersa Vain. Hedwigia 46:168. 1907. Type collection: Lem Ngob, Thailand, *Schmidt* XV, XXXIV (TUR, syntypes; isosyntypes in C).

All of the collections seen are fragments. The chemical reaction in the medulla is K+ yellowish, C−, P+ orange red; the P+ reaction is caused by an unknown substance. Des Abbayes (1958) reported this species from Africa, but I have not seen the specimen he cited.

Parmelia arechavaletae Müll. Arg. Rev. Mycol. 10:1. 1888. Type collection: Montevideo, Uruguay, *Arechavaleta* (G, holotype).

The type collection is fragmentary and has been damaged by insects. Atranorine and stictic acid were proved, indicating that the species, if isidiate, is probably synonymous with *P. crinita* Ach.

Parmelia coriacea contexta Eschw. *in* Mart. Fl. Brasil. 1:209. 1833. Type collection: Amazon River, *Martius*.

The type has not been located and may be lost. Eschweiler's notation that it is near *P. conspersa* might mean that it is not an *Amphigymnia* species.

Parmelia coriacea rufa Eschw. *in* Mart. Fl. Brasil. 1:208. 1833; Icon. Sel. Crypt. p. 23, *pl. 13, fig. 2.* 1827. Type collection: Amazon River, *Martius.*

The type has not been located and the illustration does not help in further identifying this taxon.

Parmelia coriacea var. **urceolata** (Eschw.) Eschw. *in* Mart. Fl. Brasil. 1:207. 1833.

See entry under *Parmelia urceolata.*

Parmelia crinita Meyer, Entw. Metamor. Fortpfl. Fl. 23. 1825 (non Ach. 1814). Type collection: Rio de Janeiro, Brazil, *Beyrich.*

The type collection has not been located; the original description is extremely brief.

Parmelia crinita f. **varians** Merrill, Bryol. 11:95. 1908. Type collection: Carleton Place, Ontario, *Macoun* 3828.

The type collection was not found at Farlow Herbarium. It is probably synonymous with *P. crinita* Ach.

Parmelia flaveola Hillm. Repert. Sp. Nov. Fedde 49:197. 1940. Type collection: Na Pali-Kona Forest Reserve, Kauai, Hawaiian Islands, *Krajina* 425.

The type specimen was destroyed in World War II.

Parmelia hildebrandtii var. subcetraria Jatta, Malpighia 19:171. 1905. Type collection: Mt. Singalang, Sumatra, *Beccari* 285, 286.

The type collections have not been located.

Parmelia melanoleuca (Willd.) Zenk. Pharm. Waarenk. 1:156. 1827.
Lichen melanoleucus Willd. *in* Röm. & Usteri, Mag. für Bot. 4:9, *fig. 2.* 1788.
Type collection: America meridionalis, s.c.

In Zahlbruckner's Catalogus this species is listed as a synonym of *P. perforata* (Jacq.) Ach., which does not occur in tropical America. A possible isotype (M) labeled "Auf Cort. Chin." contains stictic acid and apparently equals *P. crinita* Ach. The original collection is probably at Berlin, but I have not had an opportunity to examine it.

Parmelia melanothrix var. **lacinulata** Müll. Arg. Flora 74:376. 1891. Type collection: Andes, Bolivia, *Pearce* (K, holotype; G, isotype).

The type is a sterile species of the series *Ornaticolae* with alectoronic acid and without soredia or isidia. It is near *P. argentina* Kremplh. but cannot be identified without spores.

Parmelia modesta Hue, Bull. Soc. Bot. Fr. Mém. 63 (28): 6. 1916. Type collection: British Africa, *Poncins.*

This species is missing from the collections at Paris.

Parmelia munda (Harm.) Gyel. Repert. Sp. Nov. Fedde, 30:225. 1932.

See the entry under *P. trichotera* f. *munda* Harm.

Parmelia novoguinensis Hillm. Repert. Sp. Nov. Fedde 50:334. 1941. Type collection: Station Felsspitze, New Guinea, *Ledermann* 12852.

The holotype specimen was destroyed in World War II and it is not known whether there were any isotypes.

Parmelia paxinoides Dodge, Ann. Mo. Bot. Gard. 46:119. 1959. Type collection: Andrangolaoka, Imerina, Madagascar, *Hildebrandt* (FH).

The holotype could not be found in the Farlow Herbarium. Dodge often failed to annotate his type specimens with the result that they are filed under the original determinations and effectively lost.

Parmelia pedicellata var. **isidiosa** Dodge, Ann. Mo. Bot. Gard. 46:144. 1959. Type collection: Bugishu, Bulambuli, Uganda, *Thomas* 549 p.p. (K)

The type collection was not found at Kew.

Parmelia perforata var. **denticulata** Lindsay, Trans. Roy. Soc. Edinburgh 22:212. 1859. Type collection: Singalelah, Sikkim, *Hooker* (K).

The type collection could not be found at Kew or the British Museum.

Parmelia perforata var. **digitata** Lindsay, Trans. Roy. Soc. Edinburgh 22:212. 1859. Type collection: Pedra Bonita, Brazil, *Gardner* in 1836 (K).

The type collection could not be found at Kew.

Parmelia perforata var. **incrassata** Wedd. Mém. Soc. Nat. Sci. Nat. Cherbourg 19:264. 1875. Type collection: Île d'Yeu.

The type specimen has not been located. The description suggests *Parmelia reticulata* Tayl.

Parmelia perlata var. **ceratophylla** Mont. & v.d. Bosch. *in* Jungh. Pl. Jungh. 4:442. 1855. Type collection: Mount. Ungarang, Java.

The type specimen has not been located.

Parmelia perlata var. **cinchonarum** Fée, Ess. Crypt., suppl. 119. 1837. Type collection: Peru.

The type has not been found at either Paris or Geneva.

Parmelia perlata f. **innocua** Wallr. Fl. Crypt. Germ. 3:521. 1831. Type collection: Germany?

The type collection has not been found. Wallroth lists *P. perlata* (Huds.) Ach. as a synonym.

Parmelia perlata var. **munda** Harm. Bull. Soc. Sci. Nancy, ser. 2, 14:221. 1897. Type collection: Épinal, Vosges, France, *Berher*.

The type collection could not be found in the Harmand herbarium at Duke University.

Parmelia perlata var. **munda** subvar. **innocua** Harm. Bull. Soc. Sci. Nancy, ser. 2, 14:221. 1897.

This taxon appears to be based on the same type as *P. perlata* var. *munda* cited above.

Parmelia perlata var. **opaca** Müll. Arg. Mém. Soc. Phys. Nat. Hist. Genève 16:372. 1862. Type collection: Geneva, *Müller* (G).

Müller's original specimen could not be found at Geneva.

Parmelia perlata f. **pilosa** Grognot, Pl. Crypt. Cell. 56. 1863. Type collection: Brisecou, near Autun.

The type collection has not been found.

Parmelia perlata subvar. **punctulata** Mont. *in* Sagra, Hist. Ile Cuba. Bot. 42. 1838. Type collection: Near Havana, Cuba, *Sagra*.

The location of the type specimen is unknown.

Parmelia perlata f. **soralifera** Woron & Pachun *in* Pakhunova, Trud. Tiflissk Bot. Inst. 1:312. 1934. Type collection: Crater of Mukhera, *Pakhunova*, 1925.

The type specimen has not been examined.

Parmelia perlata f. **sorediifera** Oxner, Bull. Jard. Bot. Kiev 1:33. 1924. Type collection: Minsk.

The type specimen has not been examined.

Parmelia platycarpa Stirt. Scot. Nat. 4:252. 1877–78. Type collection: Near Brisbane, Australia, *Bailey* (BM, holotype).

The type collection is in such poor condition that it could not be used as the basis for a description. The chemical constituents are atranorine and stictic acid, and the spores, as Stirton found, are large (30–37 μ long). This species differs from others with stictic acid in lacking cilia.

Parmelia proboscidea var. **sorediifera** f. **saxicola** Ceng.-Samb. Nuov. Giorn. Bot. Ital. 45:381. 1938. Type collection: Mohulo, Kipengere, Tanganyika, *Eusebio* 13 ter.

The type specimen has not been examined.

Parmelia pseudovirens Gyel. Repert. Sp. Nov. Fedde 29: 288, 1931.

See entry under *P. virens β sorediata* Müll. Arg.

Parmelia trichotera f. **dissecta** Oliv. Mem. Acad. Cienc. Art. Barcelona, ser. 3, 16:485. 1921 [not seen].

The type specimen has not been examined.

Parmelia trichotera f. **microphylla** B. de Lesd. ex Harm. Lich. France 4:582. 1909. Type collections: Petite Synthe, Dunkerque, *Lesdain*; La Massane, Pyrenees, *Weddell*.

The specimens in Bouly de Lesdain's herbarium were lost; no duplicates have been found in the Harmand herbarium at Duke University.

Parmelia trichotera f. **munda** Harm. Lich. France 4: 582. 1909.

The type collection could not be found in Harmand's herbarium at Duke University.

Parmelia trichotera var. **plombii** B. de Lesd. Rev. Bryol. Lichen. 19:235. 1950. Type collection: Cestas, Gironde, France, *Plomb*.

The type collection has not been available for study.

Parmelia uberrima Hue, Bull. Soc. Bot. Fr. Mém. 63: 9. 1916. Type collection: British Africa, *Poncins*.

The type has not been found in Hue's herbarium at Paris.

Parmelia urceolata Eschw. Icon. Pl. Crypt. 23. 1827.

This species is illustrated by a color plate which unfortunately has so little detail that identification is impossible. It is obviously near *P. argentina* Kremplh. or *P. subrugata* Kremplh., and if the type is found (and typification is made), *P. urceolata* will be the earliest name for one of the species in this group.

Parmelia urceolata var. **sorediifera** Müll. Arg. Flora 63: 266. 1880. Type collection: Petropolis, Brazil, *Deventer* (G, holotype).

The type specimen is an indeterminable scrap.

Parmelia virens β sorediata Müll. Arg. Flora 69: 256. 1886. Type collection: Toowoomba, Queensland, Australia, *Hartmann* 49 (G, holotype).
Parmelia pseudovirens Gyel.

The type specimen is in poor condition. It is obviously close to *P. leucosemotheta* Hue since it is heavily maculate and contains salacinic acid. It could also be near *P. subsumpta* Nyl. No sound judgment can be made until additional material from Australia is seen.

Nomina Rejicienda

Parmelia glaberrima Kremplh. Flora 52: 223. 1869. Type collections: Surinam, *Wuhlschlegel* (not seen); Assam, India, *Simons* 397 (M).

This name is a later homonym of *P. glaberrima* Fr. (Syst. Orb. Veg. 1:283. 1825), a *Lobaria* species. The Assam specimen at M is too poor for adequate study.

Parmelia latissima f. sorediata Kremplh. Journ. Mus. Godeffroy 41: 100. 1873. Type collection: Ovalau, Fiji, *Gräffe* 26(?).

This name is a nomen nudum.

Parmelia neohollandica Nyl. Flora 69: 324. 1886.

Although Nylander wrote a short Latin description, there is no indication of the locality, except as indicated by the specific name *neohollandica*, i.e. Australia. The only specimen so labeled at Helsinki is an unidentifiable scrap collected by Verreaux.

Parmelia perforata var. **isidioidea** Kremplh. Denkschr. Kgl. Bayer. Bot. Gesell. 4: 130. 1861.

This is a nomen nudum.

Parmelia perforata f. sorediifera (Müll. Arg.) Merrill, Bryol. 30: 87. 1927.

The basionym of this taxon is unknown.

Parmelia perlata var. **laciniata** Nyl. Mem. Soc. Imp. Sci. Nat. Cherbourg 5: 301. 1857.

This is a nomen nudum; there is no specimen at Helsinki under this name.

Parmelia perlata var. **olivetorum** f. **isidiophora** Kremplh. Verh. Zool. Bot. Gesell. Wien 18:321. 1868. Type collection: Guatemala, 1841, *Friedrichsthal*.

This is a nomen nudum. The type specimen was not found at Munich.

Parmelia perlata var. **platysmoides** Nyl. ex Stizenb. Ber. St. Gall. Naturw. Gesell. 1888–89: 157. 1890. Cited collections: Teneriffe, *Perrandière*; Madeira, *Mandon*.

This is a nomen nudum. The first collection is at Helsinki; it is *P. crinita* Ach. The second could not be found.

Excluded Names

Many species placed in the subgenus (or section) *Amphigymnia* in catalogs and floristic lists actually belong to other subgenera in *Parmelia*. Names in the following lists, based on studies of type specimens, are drawn principally from Asahina (1952), Dodge (1959), Hillmann (1934), Lynge (1914), Magnusson (1955), Maas Geesteranus (1947), Tavares (1945), Vainio (1890), and Zahlbruckner (1909, 1929). These species are currently being investigated in the course of monographing other subgenera in *Parmelia*. They are listed here merely to justify their absence in lists of synonyms in this monograph.

The following species belong in subgenus *Parmelia*.

Parmelia albaniensis Dodge, Ann. Mo. Bot. Gard. 46:121. 1959.
P. antillensis Nyl. Bull. Soc. Linn. Norm., ser 2, 3:264. 1868.
P. aptata Kremplh. *in* Nyl. Flora 52:291. 1869.
P. badia Pers. *in* Gaud. Voy. Uranie 198. 1827.
P. balansae Müll. Arg. Rev. Mycol. 10:1. 1888.
P. balansae var. *sorediata* Müll. Arg. Rev. Mycol. 10:2. 1888.
P. biformis Vain. Phil. Journ. Sci. 4:660. 1909.
P. blastica Vain. Journ. Bot. Brit. For. 34:32. 1896.
P. canaliculata Lynge, Ark. Bot. 13, no. 13:28. 1914.
P. caperata (L.) Ach. Meth. Lich. 216. 1803.
P. caperatula (Nyl.) Nyl. Flora 68:606. 1885.
P. coralloidea (Mey. & Flot.) Vain. Acta Soc. Faun. Fl. Fenn. 7, no. 7:33. 1890.
P. crozalsiana B. de Lesd. *in* Harm. Lich. Fr. 4:368. 1909.
P. cyliphora (Ach.) Vain. Acta Soc. Faun. Fl. Fenn. 13, no. 6:7. 1896.
P. ecaperata Müll. Arg. Flora 74:378. 1891.
P. euplecta Stirt. Scot. Nat. 4:299. 1877–78.
P. ghattensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:198. 1899.
P. hansfordii Dodge, Ann. Mo. Bot. Gard. 46:127. 1959.
P. hawaiiensis Magn. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:106. 1944.
P. herreana Zahlbr. Cat. Lich. Univ. 6:239. 1929.
P. hypomilta Fée, Ess. Crypt., suppl. 123. 1837.
P. immiscens Nyl. Flora 68:606. 1885.
P. inhaminensis Dodge, Ann. Mo. Bot. Gard. 46:130. 1959.
P. leucoxantha Müll. Arg. Flora 64:85. 1881.
P. livido-tessellata Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:191. 1899.
P. martinicana Nyl. Flora 68:609. 1885.
P. meiosperma (Hue) Dodge, Ann. Mo. Bot. Gard. 46:139. 1959.

P. michauxiana Zahlbr. Cat. Lich. Univ. 6:244. 1929.
P. microsticta Müll. Arg. Flora 62:164. 1879.
P. nairobiensis Stein. & Zahlbr. Bot. Jahrb. Engler 60:517. 1926
P. negata Nyl. Bull. Soc. Linn. Norm., ser. 2, 6:270. 1872.
P. nimandairana Zahlbr. Repert. Sp. Nov. Fedde 33:55. 1934.
P. nipponica Zahlbr. Bot. Mag. Tokyo 41:353. 1927.
P. nylanderi Lynge, Ark. Bot. 13, no. 13:82. 1914.
P. olivaria (Ach.) Fr. Lich. Scand. 1:112. 1871.
P. owaniana Stirt. Trans. Glas. Soc. Field Nat. 5:213. 1877.
P. perlata var. *subrevoluta* Müll. Arg. Flora 63:267. 1880.
P. praeperlata Nyl. Flora 69:319. 1886.
P. pseudoreticulata Tav. Acta Port. Biol. 1B:138. 1945.
P. ramulicola Dodge, Ann. Mo. Bot. Gard. 46:172. 1959.
P. raunkiaeri Vain. Ann. Acad. Sci. Fenn. 6, no. 7:19. 1915.
P. riograndensis Lynge, Ark. Bot. 13, no. 13:26. 1914.
P. rudecta Ach. Syn. Lich. 197. 1814.
P. ruminata Zahlbr. *in* Magn. & Zahlbr. Ark. Bot. 31A, no. 6:107. 1944.
P. somaliensis Müll. Arg. Flora 68:501. 1885.
P. soredians Nyl. Flora 55:421. 1872.
P. steineri Dodge, Ann. Mo. Bot. Gard. 46:125. 1959 [non *P. steineri* Gyel.].
P. subcaperatula Nyl. Flora 68:606. 1885.
P. subglauca Nyl. *in* Gasil. Journ. de Bot. 8:126. 1894.
P. subpluriformis Zahlbr. Denkschr. Akad. Wiss. Math. Naturw. Wien 83:172. 1909.
P. subpraesignis Nyl. Lich. Environ. Paris 36. 1896.
P. tabacina Mont. & v.d. Bosch. *in* Mont. Syll. Gen. Sp. Crypt. 327. 1856.
P. wainioana Lynge, Ark. Bot. 13, no. 13:87. 1914.
P. wallichiana Tayl. London Journ. Bot. 6:176. 1847.

The following species should be classified in the subgenus *Xanthoparmelia* (Vain.) Hale.

Parmelia amphixantha Müll. Arg. Flora 71: 139. 1888.
P. dichotoma Müll. Arg. Flora 69: 257. 1886.
P. hypopsila Müll. Arg. Flora 70: 317. 1887.
P. implexa Stirt. Ann. Rep. Trans. Glasgow Soc. Field Nat. 1872–73: 20. 1873.
P. stramineonitens Zahlbr. Ann. Hist. Hofm. 11: 195. 1896.
P. subflabellata Stein. Bull. Herb. Boiss., ser. 2, 7: 639. 1907.
P. wrightii Dodge, Ann. Mo. Bot. Gard. 46: 128. 1959.
P. zeyheri Dodge, Ann. Mo. Bot. Gard. 46: 132. 1959.

The following species have pseudocyphellae and are related to *Parmelia cetrarioides* (Del.) Nyl. The exact position of this group in the genus *Parmelia* has not yet been determined.

Parmelia andreana Müll. Arg. Rev. Mycol. 1: 169. 1879.
P. cetrarioides (Del. *ex* Duby) Nyl. Flora 52: 289. 1869.
P. ethiopica Dodge, Ann. Mo. Bot. Gard. 46: 123. 1959.
P. kernstockii Lynge & Zahlbr. *in* Zahlbr. Ann. Nat. Hofm. Wien 27: 271. 1913.
P. lobarina Zahlbr. Ann. Mycol. 10: 381. 1912.
P. manshurica Asah. Journ. Jap. Bot. 17: 75. 1941.

P. nitescens Stirt. Scot. Nat. 4: 299. 1877–78.
P. praesignis Nyl. Bull. Soc. Linn. Norm., ser. 2, 6: 270. 1873.
P. pseudolivetorum Asah. Journ. Jap. Bot. 26: 16. 1951.
P. soredica Nyl. Flora 68: 605. 1885.

The following two species should be classified in the genus *Cetraria*.

Parmelia arisanii Zahlbr. Repert. Sp. Nov. Fedde 33: 57. 1934.
P. braunsiana Müll. Arg. Flora 64: 506. 1881.

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